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ORIGINAL ARTICLES.

I.—Notes on British Dinosaurs. Part IV: *Stegosaurus priscus*, sp. nov.

By Baron Francis Nopcsa.

(WITH NINE ILLUSTRATIONS IN THE TEXT.)

(*Concluded from the March Number, p. 115.*)

Limb-bones.—Since the humerus is known in *Hylæosaurus* (?), *Omosaurus*, and *Stegosaurus*, it is quite easy to compare the humerus of our new species with that of the other genera mentioned. Whether the shaft is hollow as in *Omosaurus* or solid as in *Stegosaurus*, cannot be ascertained without breaking the specimen; the outline of the new humerus is, however, that of *Omosaurus*, not that of *Stegosaurus*.

Fig. 4. Humerus of *St. priscus*. *a*. Posterior view of proximal end. *b*. Anterior view of distal end.

The proximal condyle was situated, as far as can be made out, much as in *O. armatus*, and the radial crest shows also the same curve as in this species; the anconeal ridge, however, is more strongly developed, and ends distally in a broad rugose area somewhat above the middle of the bone (Fig. 4*a*). The anconeal depression and the trochlear groove (visible in Fig. 4*b*) are less marked in *St. priscus* than in *O. armatus*. The ridge for the supinator is broken off in the new specimen, but if preserved it would give to the distal part of the bone a rather dilated aspect, and thus produce a certain resemblance to *St. ungulatus*.

Though the humerus we are considering has been somewhat flattened by crushing, the inward bend of the radial crest does not seem to have been as strong as in the humerus referred by Hulke to *Hylæosaurus*, with which it might otherwise be well compared. The total length of the humerus is 50 cm.

The ulna of *O. armatus* is too much mutilated to be compared with the same bone in *St. priscus*. If, however, we compare the ulna of *Stegosaurus*, we find that it is less dilated at the proximal end and that its shaft is much more slender (Fig. 5). The length of the ulna from the humeral articular surface to the distal end is 40 cm.

A large irregular flattened bone of somewhat parallelopiped shape, the structure of which would indicate that it was almost completely covered by a thin layer of cartilage, may be regarded as a proximal carpal, though from lack of comparative material its position cannot yet be determined with precision.

FIG. 5. Ulna of *St. priscus*.

According to Marsh separate carpals characterize the genus *Diracodon*, and this would tend to indicate a close affinity between our *Stegosaurus* and this genus, but I am quite open to the suggestion that such a fusion of carpals in some Dinosaurs may be due only to old age, and hence may not have either generic or even specific value.

The femur of the new *Stegosaurus* (Fig. 6*c*) is a long, straight, and rather slender bone, somewhat compressed from back to front at each

end, and showing a well-developed articular surface suggestive of that in the femur of a chicken in which the epiphyses are not yet fused with the bone or have been artificially removed by roasting and boiling afterwards. The articular surfaces on the femur of *St. priscus* are not flat but rugose, and show irregular grooves and furrows resembling those of the bone-surface to which the epiphysis is attached in birds and mammals. The manner in which these surfaces pass into the rest of the bone is likewise the same as in the strongly macerated chicken just mentioned. The lack of a pit for the attachment of the ligamentum teres is another noteworthy feature of *St. priscus* and all Stegosauridæ, and the whole character of the articular surface is entirely different from that of the Ornithopodous femur where a pit for the ligamentum teres is indicated. To show the differences here referred to, a strongly macerated femur of *Gallus*

FIG. 6. Femora of various animals. *a*. Strongly macerated femur of *Gallus*. *b*. Non-macerated femur of the same. *c*. Femur of *St. priscus*. *d*. Femur of *Hypsilophodon Foxii*.

(Fig. 6*a*) and another which has not been macerated (Fig. 6*b*), besides a well-ossified femur of *Hypsilophodon* (Fig. 6*d*), showing the pit for the ligamentum teres, and the femur of *St. priscus*, have been drawn together of equal size in Fig. 6, and it is thus easy to see between which bones there is the greater resemblance. I do not wish to imply by pointing to these similitudes that *Stegosaurus* had separate epiphysial bones, but I wish to emphasize the fact that in this genus the amount of cartilage on both ends of the femur was decidedly much greater than in the Ornithopodidæ, and that the shape of the proximal and distal end of the bone must have been originally somewhat different from the present shape. The lack of a trochlea on the distal end of the femur of *Stegosaurus* can give us a clue to the amount of cartilage missing, for *Stegosaurus*, being a terrestrial animal, cannot have walked, and especially sat down without bending its

knees sometimes for more than 90 degrees, while as shaped in the fossil the tibia would become dislocated if forced to make an angle of more than 45 degrees with the femur. This tends to show that the cartilage on the distal end of the femur must have been at least 4 cm. thick, and this is certainly not too much when we consider that the distal femoral cartilage of the macerated *Gallus* figured above had a thickness of 4·5 mm., while the femur itself measured 94 mm. in length. It becomes evident that just as we could never try to bring the macerated femur of *Gallus* into correct juxtaposition to the acetabulum without allowing for a great amount of cartilage, so we cannot base any conclusion as to the position or direction of the femur in *Stegosaurus* exclusively on the shape of its articular surface; and this must be emphasized all the more since such an attempt has recently been made by Tornier in regard to the similarly-shaped femur of *Diplodocus*. The reason why the discussion of the femoral cartilage caps of *Omosaurus* needs to be so detailed is, that Tornier has recently expressed the belief that the similarly-shaped femur of *Diplodocus* was only covered with a few millimetres of cartilage.

Even by those who hold the contrary view the amount of cartilage in *Diplodocus* is thought to be correlated with the aquatic habits of this monster, but this theory cannot apply to the heavily armoured Stegosaurs. I quite believe that the feeble ossification of the sternal apparatus and the low degree of ossification of the distal carpals and tarsals in *most* Dinosaurs are much more likely to explain the great cartilage caps on the femora of the Stegosauridæ and similar animals than the hypothetical aquatic habits. These features and the coarse structure of the bones indicate a low degree of ossification in the whole body, and the great masses of cartilage were probably needed to ensure the continuous increase of size throughout life. Perhaps this was one of the causes for the rapid extinction of the Sauropoda.

Besides the development of the so-called articular surfaces, the feeble development of the fourth trochanter is an interesting feature in the femur of our new *Stegosaurus*. According to Marsh's description the femur of the American *Stegosaurus* shows no marked fourth trochanter, while *St. durobrivensis* bears this process. The femur of the type-specimen of *O. armatus* is too badly crushed to show this feature; on *O. vetustus*, according to F. von Huene, there is no such process. *O. Lennieri* shows a rounded but marked swelling with a rugose surface that can well be called a distinct fourth trochanter, and *St. priscus* bears on the interior posterior surface, rather high up on the shaft of the bone, an obtuse swelling, which dies out very rapidly both upwards and downwards, and must be considered as the last trace of this trochanter. It may be concluded that the variable development of the fourth trochanter affords a good character for distinguishing the different species of Omosaurs and Stegosaurs.

The tibia and fibula (Fig. 7) are represented by more than half of each bone in *St. priscus*. Like in the Ceratopsidæ and *St. angulatus*, the strong tibia is distally enlarged and flattened on the antero-exterior border for the reception of the fibula. Both bones are so closely applied against each other and to the fused calcaneum and astragalus that this part of the foot formed one inflexible piece.

Although the tibia is imperfect at its proximal end its length can be estimated at 57–60 cm.

Since, as already mentioned, the femur of *St. priscus* measures 90 cm. in length, the ratio of these two bones in this species is 2 : 3, while according to Marsh's figures it is something like 7 : 4 in *St. ungulatus*.

FIG. 7. Anterior view of tibia and fibula of *St. priscus*.

The ratio between humerus and femur is: 1 : 2·3 in *St. ungulatus*; 5 : 9 in *St. priscus*; 4 : 5 in *O. armatus*. Thus, in the length of the limb-bones *St. priscus* is intermediate between the two other forms.

Pelvis.—With the help of Mr. D. M. S. Watson, of Manchester, three most unpromising pieces of bone have been made out to represent pieces of the ilia. The left post-acetabular process and portions of the margins of both ilia just near the acetabulum are present. Though not very characteristic and rather crushed, the post-acetabular process agrees in its slender shape rather with *O. Lennieri* and *armatus* than with *Stegosaurus*, but the absence of the rest of the ilium is to be regretted all the more, since this bone is the most characteristic for separating the genera *Omosaurus* and *Stegosaurus*.

The slender pubis of *St. priscus* (Fig. 8*a*) is a very remarkable element. Its anterior branch, corresponding functionally, though not in its origin, to the processus pectinealis of birds, and therefore appropriately named processus pseudopectinealis, is badly fractured; but from the part preserved we may infer that it had a long, slender, blade-like shape, as in *O. armatus* (Fig. 8*a*), but was more inclined downwards than in this genus. The foramen obturatorium is open towards the suture of the ischium, as in *St. angulatus* and *Omosaurus*. The acetabulum is but feebly marked and disfigured by crushing; the post-acetabular part of the pubis is a slender rod-like bone, of which the middle part is wanting. The distal end of the pubis is thickened and covered with rugosities, which form, where the pubis originally met the ischium, a horseshoe-shaped area. This area and a strong

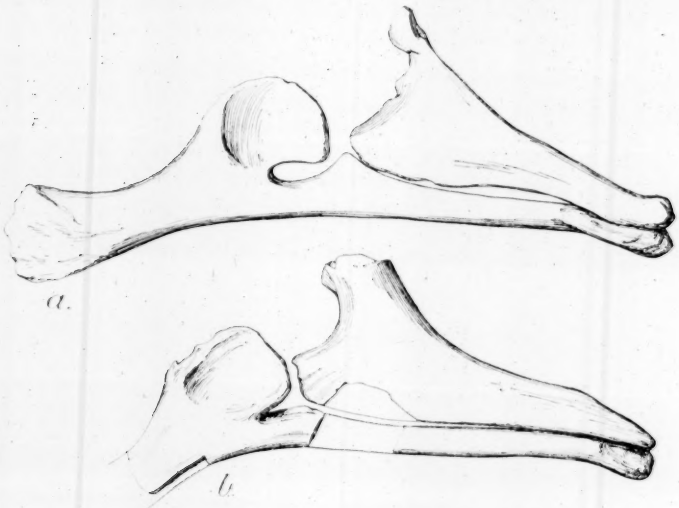


FIG. 8. *a*. Ischium and pubis of *O. armatus*. *b*. The same of *St. priscus*.

projecting rugosity on the inferior surface of the shaft of the pubis were both well figured by F. von Huene in the *Centralblatt für Mineralogie*, etc. (1902), when discussing the Cambridge specimen of *St. priscus*.

In consequence of its slender rod-like shape, the pubis of *St. priscus* resembles the same bone in *O. armatus* more than in *Stegosaurus*, but the rugosity on the shaft is wanting in *O. armatus*. A slender rod-like post-pubis is present also in *O. Lennieri*. Some evidence that the pubis of *St. priscus* was more slender than the same bone in *O. armatus* is afforded by the shape of the well-preserved ischium. This bone (Fig. 8*b*) is a long, triangular, flat element, showing a concave surface only at the acetabulum and tapering in the usual *Omosaurus*-like manner towards its distal end, which is triangular in section and is applied closely to the pubis. Further forwards

a longitudinal cleft occurs between these two bones. Compared with the ischium of *O. armatus* (Fig. 8*a*) it may be seen that the distal half, though it has on its upper margin the notch characteristic of *Stegosaurus*, is much more slender in *St. priscus*, but the flat, desk-like shape is the same in both animals. If we compare this type of ischium with the same bone in *St. angulatus* or *O. Lennieri* we find a fundamental difference, for in these two genera the ischium is not flat but twisted, and the superior margin of the ischium curves in such a manner as to meet in the median line at the proximal part of the rather long ischiadic symphysis, so that a great part of the ischium is thus modified into a horizontal plate that overlies the pubis. I am at a loss how to explain this difference in two forms so closely allied, for it seems difficult to explain it simply through post-mortem pressure. The longitudinal cleft between the pubis and the ischium, which is present in both species of *Omosaurus* and our Stegosaurian, is a character found in all primitive Ornithopoda; the closing of this cleft observable in *St. angulatus* must therefore be regarded as a mark of specialization.

To facilitate a comparison of the ischia of *O. armatus* and *St. priscus* it has been thought advisable to figure these bones of both species near each other, and this seems all the more necessary because the pelvis of *O. armatus* has never yet been figured in the proper position.

Dermal Armour.—Associated with the bones just described several badly crushed pieces of dermal armour were discovered. Both spines and plates are present.

The plates are somewhat asymmetrical. Towards their base they are rounded and equally rugose on the exterior and interior margin, thus proving that they rose nearly vertically out of the skin; since, however, they are all more or less in a fragmentary condition, it seems enough to publish only a diagram of the transverse section (Fig. 9*a*) to show how this kind of plate would be inserted in the tissue of the body.

Though as badly preserved as the plates, the two spines found among the material show such peculiar features as to justify a more detailed description. The fragments are nearly similar, and include in both cases the base of a spine and its attachment-surface. The height of the specimen figured is 29·5 cm., its breadth 10 cm., its thickness at the summit 2·5 cm.

Of the upper part probably three-fourths or more is missing, but the base is entire and scarcely deformed by crushing. The piece shows an anterior and a posterior ridge, a more concave outer and a flatter inner surface, the latter being divided into a superior and an inferior half. On the outer side (Fig. 9*b*) at the base only a narrow rugose margin is observable; on the inner side, however, the rugose area reaches much higher (Fig. 9*c*) and occupies nearly half of the fragment, making an obtuse angle with the upper half of the spine. The great extent of the rugosity on the inner surface and the flatness of the surface over which the rugosities extend prove that while the exterior part of the bone was only slightly embedded in soft tissue, the interior side continued to adhere to the skin up to a much higher point; hence we may conclude that this spine rose, as indicated in

Fig. 9*d*, very obliquely from the body, or else that the curve to which it was attached must have had at least a diameter of 80 cm., if not much more.

As the lack of rugosities and the small size of the later caudals show that the end of the tail of *St. priscus* was *not* covered by powerful muscles and can scarcely have attained a diameter of 40 cm., it is evident that these two particular spines of *St. priscus* cannot have been situated on the tip of the tail, but must have been on some other part of the body. Leaving the shape of the spines entirely out of consideration, and judging only from the evidence afforded by the other armoured European Dinosaurs, notably *Scelidosaurus* and also *Hylæosaurus* and *Polacanthus*, one would never be induced to place the dermal spines on the tail of our Stegosaurian, but on the scapular region. This determination is apparently supported by the shape of the actual surfaces of attachment of the bones in question.

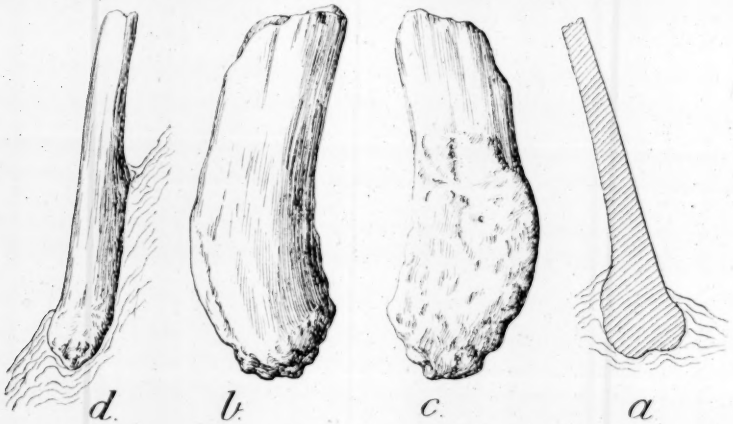
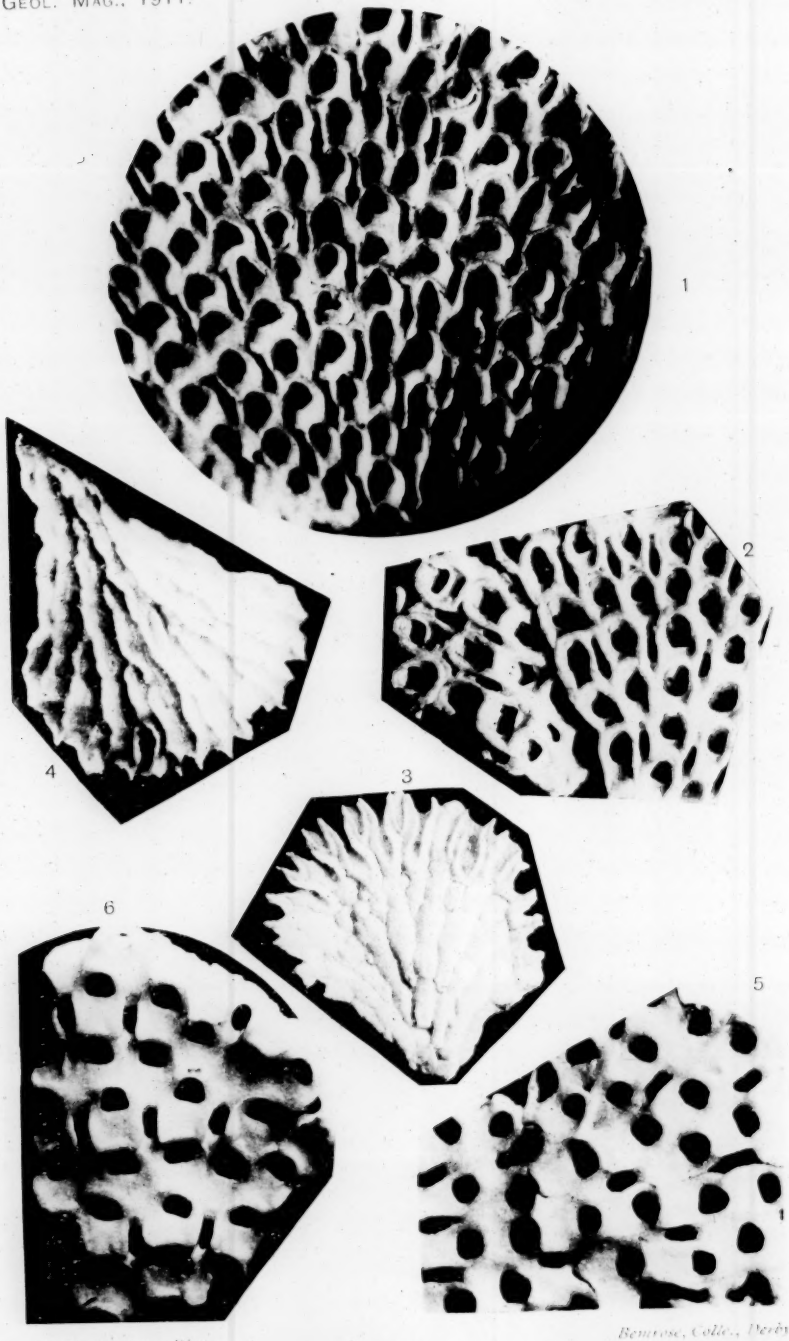


Fig. 9. *a*. Transverse section of dorsal dermal plate of *St. priscus*, with indication of hypothetical attachment to body-tissue. *b*. Exterior view of spine of the same animal. *c*. Interior view of the same piece. *d*. Marginal view of the same piece, with indication of hypothetical body-tissue.

Conclusion.—As already pointed out in the course of this paper, *St. priscus* agrees in the stage of evolution of its dorsal vertebræ somewhat with *St. ungulatus*, while in its limbs it holds an intermediate position between *O. armatus* and *St. ungulatus*. In its pelvis it corresponds with the genus *Stegosaurus*, though representing a new species.

Considering the development of the preacetabular part of the ilium as a generic character, we may arrange the members of the genera *Stegosaurus* and *Omosaurus* in the following manner:—

Genus Omosaurus (Owen). Ilium not very elongate anteriorly, widening backwards rapidly towards the acetabulum and the first sacral vertebra, its anterior extremity rounded. Neural arch of dorsal vertebræ slightly elevated. Five sacral ribs present. Sacrum much depressed from top to bottom.



R. M. Bradow, Photo. Bemrose, Collo., Derby.

NEW CHALK POLYZOA.

O. armatus (Owen). Dorsal vertebræ with lateral pits; sacral vertebræ not much abbreviated. Ratio between humerus and femur 4 : 5. Articular ends of femur not much expanded.

O. Lennieri (Nopcsa). Dorsal vertebræ without lateral pits; sacrals strongly abbreviated. Fourth trochanter feeble but well marked. Articular ends of femur not much expanded.

O. retustus (Huene). Articular ends of femur moderately expanded, without fourth trochanter.

Genus Stegosaurus (Marsh). Ilium very elongate anteriorly, its breadth increasing only gradually backwards. Four sacral ribs present. No very great dorso-ventral compression of the sacrum. Articular ends of femur not expanded.

St. durobrivensis (Hulke). Femur with strong fourth trochanter.

St. priscus (Nopcsa). Neural arches of dorsal vertebræ moderately elevated. Femur with rudiment of fourth trochanter. Ratio of humerus to femur 5 : 9.

St. ungulatus (Marsh). Neural arches of dorsal vertebræ very much elevated; sacrals not much abbreviated. Femur without fourth trochanter. Ratio of humerus to femur 1 : 2·3.

II.—Notes on new or imperfectly known Chalk Polyzoa.

By R. M. Brydone, F.G.S.

(*Continued from Decade V, Vol. VII, p. 483, 1910.*)

(PLATES IX AND X.)

Pavolunulites scandens, sp. nov. Pl. IX, Figs. 1–4.

Zoarium free, unilaminate, the back divided by somewhat wavy, shallow, slightly diverging furrows into long narrow strips which correspond with the lines of zoœcia; these strips are occasionally crossed by very shallow depressions or furrows corresponding to the boundaries of individual zoœcia.

Zoœcia disposed in gently diverging and outward-curving lines, which are in some places confluent and in others separated by vibracularia; they are short and broad, with bulging sides, but very variable in size and outline, average length ·55–·6 mm., breadth (maximum) ·6 mm.; the back wall very soon leaves the back of the zoarium and rises gently but steadily up to the level of the front wall at the head of the zoœcium, and the succeeding zoœcium grows out from beneath it; in the shallow part of the back wall may sometimes be observed a pair of large foramina; the aperture is terminal and large, occupying the upper two-thirds of the area, irregular in size and shape, but varying round a type which is long, broad, and nearly rectangular, with rounded corners, rather wider at the foot than the head and with a slight inflexion of the sides; at the head the outline often becomes indistinct; a fairly typical length of aperture would be ·35–·4 mm., and breadth ·25–·27 mm.

Oœcia small, inconspicuous swellings at the head of the zoœcium;

one can be seen in the upper left-hand part of Pl. IX, Fig. 1, near the margin.

Vibracularia set very deep between the zoœcia, whose bulging sides as a rule overhang them sufficiently to hide part of the aperture, which is long and narrow, rounded above but tending to be pointed below; below the aperture the front wall usually rises quickly to a point between converging zoœcia; above the aperture the front wall usually rises very little and abuts at some depth against the succeeding zoœcium of one of the adjoining lines.

In general structure this species is closely related to the form described by Beissel as *P. costata*, D'Orb., but is easily distinguishable by the size and shape of the aperture and of the zoœcia generally. It seems to be confined to the upper part of the *M. cor-testudinarium* zone, where it is not uncommon on the Sussex coast and may reach a very considerable size, my largest specimen (a broken one) being 9·2 mm. by 15·5 mm.

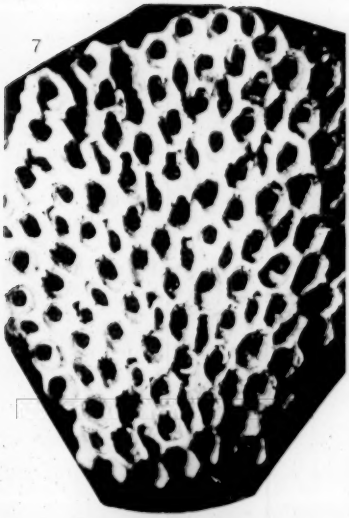
PAVOLUNULITES DECLIVIS, sp. nov. Pl. IX, Figs. 5 and 6.

SYN. *Pavolunulites costata*, Beissel, Bryozoen der Aachner Kreidebildung, p. 37, pl. iii, figs. 39–41.

Semieschara costata, Marsson, Bryozoen der Weissen Schreibkreide der Insel Rügen, p. 76.

Non *Pavolunulites costata*, D'Orbigny, Paléontologie Française, vol. v, p. 359, pl. 706, figs. 9–11.

A form of *Pavolunulites* closely allied to *P. scandens* occurs in the zone of *Act. quadratus* and at Trimingham. It is apparently identical with the form described and figured by Beissel as *P. costata*, D'Orb. (after comparison of his specimens with D'Orbigny's single "defective" type). This identification was accepted by Marsson, but with obvious misgivings, which seem justified. D'Orbigny's figure is not clear enough to give details accurately, and the only substantial character furnished by his description is the ribbed back, which is wholly different in type from that of the Aachen and English forms. The broad characters of the back are so constant among the Lunulitidæ that I cannot ignore this difference, and I therefore give Beissel's form a separate name. There is also no sign in Beissel's figures or description of the raised rim to the aperture mentioned by D'Orbigny. The English specimens agree very closely with Beissel's admirable figures. The species is clearly distinguished from *P. scandens* by the longer and narrower zoœcium with a sub-quadrate longitudinal section (due to the steep descent of the wall from the head of the zoœcium to the back wall, in consequence of which it is only faintly visible within the aperture), the broader and much shorter zoœcial aperture varying round a semicircular type and the shorter and broader vibracularian aperture. *P. elegans*, D'Orb. (loc. cit., p. 359, pl. 706, figs. 5–8), agrees very closely in the pattern of the back, but is readily distinguished by the pointed zoœcia. *P. elegans*, Beiss., appears to be a different species, so named by oversight, and may be known as *P. Aquensis*. I have not seen any definite oœcium.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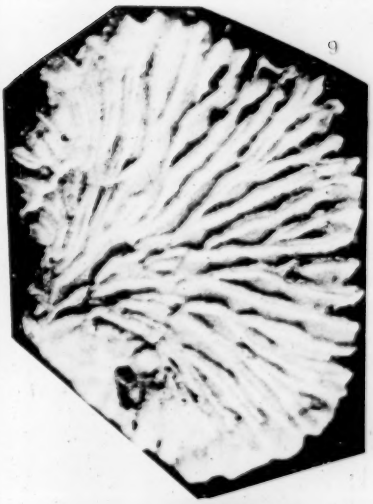
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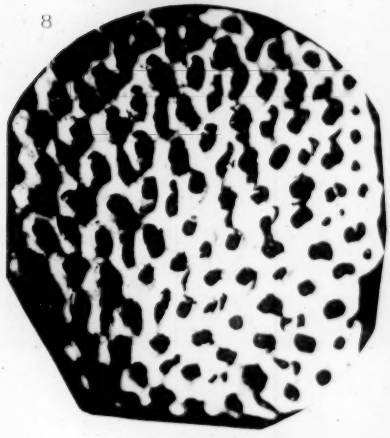
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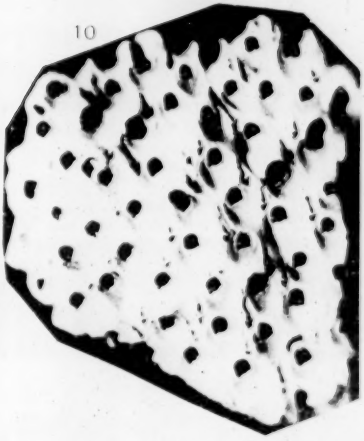
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R. M. Bryzone, Photo. Bibliography Coll., Photo.

NEW CHALK POLYZOA

It occurs very sparingly in the *Act. quadratus* zone of Hants and the Isle of Wight, and at Trimingham.

Pavolunulites subquadrata, sp. nov. Pl. X, Figs. 7–9.

Zoarium free, unilaminate; my specimens range from 3·4 mm. by 3·6 mm. up to 6·5 mm. by 8·1 mm., the back covered with numerous prominent flattened radiating ribs, many of which show a faint median furrow.

Zoœcia small, average length ·5–·55 mm., breadth ·35–·45 mm., arranged in slightly diverging rows; intercalated rows beginning with a vibracularium; aperture nearly terminal, rather longer than wide, and slightly wider below than above, corners rounded below and square above; two little nicks in the margin may often be seen at the head of the zoœcium.

Oœcia short and wide, only partially attached by the under side and with the free edge deeply cut back into a semicircle.

Vibracularia shallow, with a long narrow aperture tapering above to a rounded end, but below to a pointed end; above the aperture the front wall does not rise, but abuts at some depth against the succeeding zoœcium. They are sometimes vicarious.

Common in the upper part of the *M. cor-testudinarium* zone on the Sussex and Isle of Wight coasts, and I have also found it at the same horizon in Hants. I believe it to be confined to this zone.

A friend has pointed out that I have nowhere mentioned that my photographs are touched up before reproduction. This is a fact and I have found it inevitable, as the shortness of focus of the camera and the irregularity of surface of the fossils make it hopeless to expect photographs sharp enough to be really illustrative. To demonstrate this I have for this and the succeeding species given an exceptionally good photograph *au naturel* and a much inferior one touched up, and I do not think there can be any doubt which is which, or which is the more precise.

Lunulites Marssoni, nom. nov. Pl. X, Figs. 10–12.

Syn. *Semieschara crassa*, Beissel, op. cit., p. 42, pl. iv, figs. 47–50; Marsson, op. cit., p. 75.

Fragments of a form corresponding closely with Beissel's figures of *Semieschara crassa* are not uncommon at Trimingham. The only points in which they differ are that the posterior slit in the vibracularia has become a wide deep-set opening and that the aperture of the vibracularia has become more or less pointed anteriorly, points which do not appear to justify even varietal recognition. One or two of my larger fragments would strongly suggest that they are parts of a Lunulite, and fortunately I have obtained one practically perfect circular Lunulitine specimen, whose diameter is about 9·7 mm. No doubt the deep irregular depressions exemplified in Fig. 12 form lines of weakness along which large specimens break readily. Unfortunately there is already a *Lunulites crassa* (Tenison-Woods, Trans. Roy. Soc. S. Austr., iii, p. 5), and I have renamed the species after the second of the only two authors who refer to it, the name of the first not being available.

EXPLANATION OF PLATES IX AND X.

(All figures magnified 12 diams.)

PLATE IX.

FIG. 1. *Parolunulites scandens*, sp. nov. Part of a good-sized specimen. Seaford.
,, 2. Ditto. A specimen which was easy to clean out and shows the foramina in the back wall. Seaford.
,, 3. Ditto. Back of a small specimen. Seaford.
,, 4. Ditto. Back of a larger specimen showing at one point traces of the marginal growth-outline not obliterated in the centre of the zoarium. Seaford.
,, 5. *Parolunulites declivis*, sp. nov. Part of a large fragment. Trimingham.
,, 6. Ditto. A small fragment. Trimingham.

PLATE X.

FIG. 7. *Parolunulites subquadrata*, sp. nov. Nearly the whole of a zoarium. Seaford.
,, 8. Ditto. A zoarium. Basing Park, Hants.
,, 9. Ditto. Back of a zoarium. Seaford.
,, 10. *Lunulites Marssoni*, nom. nov. A fragment. Trimingham.
,, 11. Ditto. Part of another fragment. Trimingham.
,, 12. Ditto. Back of another fragment. Trimingham.

III.—On *Pleurocaris*, a new Crustacean from the English Coal-measures.

By W. T. Calman, D.Sc.

THROUGH the kindness of Mr. Walter Egginton I have recently had an opportunity of studying an interesting series of Crustacea from the Coal-measures of Coseley, near Dudley. Most of the specimens can be referred, with more or less probability, to the division Syncarida, which includes the living *Anaspides* and its allies, and among them are some which I regard as representing a new genus. Although the fossils, which are contained in nodules of clay-ironstone, often show very minute details of structure in a beautifully perfect state, it is just those features most important from a morphological point of view that are most frequently obscured. There are many essential points that cannot be determined from the material at my disposal, and the conclusions drawn as to the systematic affinities of the genus must therefore be regarded as to some extent provisional.

Sub-class MALACOSTRACA.

Division SYNCARIDA (?).

PLEUROCARIS ANNULATUS, g. et sp. n.[1]

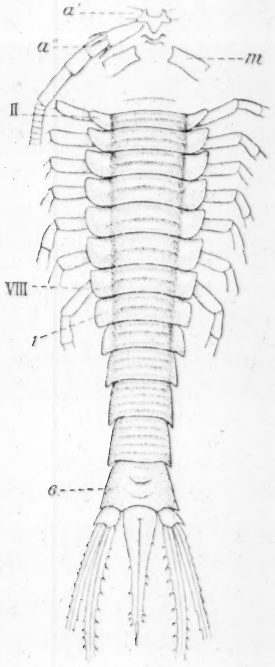
The body measures approximately 14 mm. in total length, and 2·9 mm. across the widest part. It is extended or only slightly curved ventrally, and the dorsal surface is exposed in all the specimens.

The *head* is obliterated in all the specimens seen, and only impressions of some of its appendages are preserved. What appear to be the basal segments of the *antennules* are seen in front, on either side of a small triangular median plate. Behind these is a stout *antenna* with a peduncle of three (?) segments and a portion of a flagellum showing

[1] For a diagnosis of the genus see p. 160.

indistinct traces of many small segments; a group of three or more large spines is placed, apparently, at the distal end of the first visible segment of the peduncle. A pair of large impressions a little way behind the antenna represent, in all probability, the *mandibles*.

The *thoracic region* consists of seven free somites, although the first (the second of the complete series of eight) is not perfect in any of the specimens. Each somite is roughly semicircular in transverse section, and has a pair of horizontally expanded *pleural plates* overhanging the attachment of the limbs. The antero-posterior length of the somites increases from the first to the fourth or fifth, and the



Pleurocaris annulatus. Partial restoration of the dorsal surface. × 6. Based chiefly on specimens Nos. 18 and 23 in Mr. Egginton's collection. Drawn by Miss G. M. Woodward. *a'*, antennule (?); *a''*, antenna; *m*, mandible; II, second thoracic somite; VIII, eighth thoracic somite; 1, first abdominal somite; 6, sixth abdominal somite.

pleural plates, at first bluntly pointed and slightly produced forwards, become more square-cut on the posterior somites. The dorsal surface of the somites is marked with strong transverse ridges, giving the body an annulated appearance and making the limits of the somites hard to define. There appears to be one ridge about the middle of each somite, and two others, which only become prominent on the hinder somites, at the anterior and posterior margins respectively. The thoracic *legs*, of which seven pairs can be made out, are all similar and rather stout. No distinct traces of exopodites can be seen.

The *abdomen*, excluding the telson, is longer than the seven thoracic somites together. The six somites increase in length from before backwards, and the pleural plates, horizontal and square-cut like the posterior thoracic pleura on the first somite, become bent downwards and acutely pointed backwards on the posterior somites. The abdomen thus appears narrowed posteriorly, but the actual width of the somites is apparently not very different from that of the thorax (1·4 mm.) if the pleural plates be excluded. The dorsal surface is ridged or annulated like that of the thorax, the ridges increasing in number from about three on the first somite to about five on the fifth. The exact number of ridges, however, is difficult to make out, owing to crushing and to the obscure delimitation of the somites. The sixth somite has two short crescentic ridges with the ends turned forwards but not extending to the margins of the somite. The pleopods are not visible.

The *telson* is separated from the last somite by a distinct line of articulation, and is at least a little longer than the last three somites together, but the tip is not perfect in any of the specimens. At the base it is about half as wide as the last somite, and it tapers gradually to a slender spiniform point. The lateral margins are slightly concave, and carry some short spines or teeth, but the exact number and arrangement of these could not be determined, except for a group of about three on each side at the base of the apical spine. The dorsal surface has a strong median keel.

The *uropods* are longer, probably considerably longer, than the telson. Each has a short stout protopodite, produced externally into a sharp tooth. The rami are very slender, and each is strengthened by a longitudinal keel. The exopodite is nearly straight, and is serrated on the outer, and less conspicuously on the inner, margin. The endopodite is curved inwards, and has a row of strong, widely spaced spines or teeth on the inner edge, and similar but smaller teeth on the distal part of the outer edge.

Locality.—Coal-measures, Coseley, near Dudley.

Type-specimen. No. 23 in the collection of Mr. Walter Egginton. Other less perfect specimens from the same locality in the Geological Department of the British Museum (I 13813, I 13814) are among the paratypes.

As regards the affinities of the species here described, it is to be observed, in the first place, that the possession of a 'tail-fan', consisting of a pair of biramous appendages on either side of a median telson, shows at once that it belongs to the Malacostracous Crustacea and to the series Eumalacostraca. The absence of a carapace practically narrows the comparison, among the existing groups of Eumalacostraca, to the Isopoda and the Syncarida.

The expanded pleural plates of the thoracic region give *Pleurocaris* considerable resemblance to an Isopod, and it must be admitted as a possibility that they may indicate real affinity with that Order; but, on the other hand, there are some important features that tell against this view. In all recent Isopoda, with exception of the aberrant family Anthuridæ, the telson is coalesced with the last abdominal somite, and, as this is the case also with the Tanaidacea

and with many of the Cumacea, we must suppose this coalescence to be a very ancient character of the Order. Another important feature is the abbreviation of the abdomen, which is shorter than the thoracic region in all Isopoda and Tanaidacea. If we may assume, from the evidence of the Tanaidacea, that the acquisition of these characters preceded the suppression of the carapace in the evolution of the Isopoda, then the free telson and elongated abdomen of *Pleurocaris* suggest that it belongs to another line of descent.

The only Crustacea with which, so far as I know, *Pleurocaris* can be closely compared, are the species of *Acanthotelson* from the Coal-measures of Illinois.[1] The similarity is especially close as regards the tail-fan, both genera having the telson long and tapering to a sharp point, and the rami of the uropods very slender and armed with marginal spines. *Acanthotelson*, however, has no thoracic pleural plates, and has the first of the seven thoracic legs stouter than the others, and armed with large spines. The somites also lack the transverse ridges so conspicuous in the species here described. These differences seem to justify the establishment of a new genus for the English species, but it can hardly be doubted that the two genera are very closely allied.

I have previously expressed the view[2] that *Acanthotelson* is closely related to *Uronectes* (*Gampsonyx*), *Præanaspides*, and certain other fossil genera, which, with the living *Anaspides*, *Paranaspides*, and *Koonunga*, I have grouped together under the name Syncarida. To this view I still adhere, although I now agree with Mr. Stebbing[3] in thinking that less reliance is to be placed on Packard's restoration of *Acanthotelson* than on the original figures of Meek & Worthen. I cannot, however, agree with Mr. Stebbing that *Acanthotelson* has any but the most superficial resemblance to *Apseudes* or any other Tanaidacea. The possession of a distinct carapace coalesced with the first two thoracic somites is a universal and no doubt primitive character of that Order, while in *Acanthotelson* the second somite is certainly distinct and possibly the first also. Mr. Geoffrey Smith has suggested[4] that *Acanthotelson* may be a "generalized Amphipod", but I am unable to find any support for this view in the known characters of the fossil. *Acanthotelson* appears to agree with *Uronectes* and with *Præanaspides* in the segmentation of the thorax, and it resembles the

[1] The genus *Acanthotelson* was established by Meek & Worthen in 1865 (Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 46) for two species, *A. stimpsoni* and *A. inæqualis*, which were more fully described and figured in the following year (Geol. Surv. Illinois, ii, p. 399). In 1868 (Amer. Jour. Sci. (2), xlvi, p. 27, and Geol. Surv. Illinois, iii, p. 549) the same authors added a new species, *A. eveni*, and withdrew *A. inæqualis* as founded on an imperfect specimen of *Palæocaris*, giving also a fuller description of *A. stimpsoni* and additional figures. Packard in 1886 (Mem. Nat. Acad. Sci. Washington, iii (2), mem. 15, p. 123) discussed the genus, for which he established the group Syncarida, and gave a restoration of *A. stimpsoni*.

[2] Trans. Roy. Soc. Edinburgh, xxxviii, pl. iv, p. 799, 1896; Ann. Mag. Nat. Hist. (7), xiii, p. 155, 1904; Lankester's *Treatise on Zoology*, pt. vii, fasc. 3, Crustacea, p. 167, 1909.

[3] Natural Science, xi, p. 252, 1897.

[4] Quart. Jour. Micr. Sci., liii, p. 500, 1909.

former of these genera in having one of the anterior thoracic legs enlarged and strongly spinose; it is said to differ in having no thoracic exopodites, but even if this should prove to be the case it would not outweigh the important points of resemblance.

A PROVISIONAL DIAGNOSIS of the genus *Pleurocaris* may be given as follows:—Eumalocostraca without a carapace, with at least seven of the thoracic somites distinct and provided with horizontally expanded pleural plates; with at least seven pairs of the thoracic appendages not greatly differing in size; with the abdomen longer than the thorax; with the telson and uropods forming a tail-fan, the former distinct from the last somite and tapering to a sharp point, the latter with long narrow rami. Probably belonging to the division Syncarida and closely allied to the genus *Acanthotelson*, Meek & Worthen.

It is perhaps deserving of mention that the transversely ridged body-somites of *Pleurocaris* give it a superficial resemblance to certain Myriopods (Diplopoda) occurring in the same strata, and one occasionally finds fragments, destitute of appendages, which can with difficulty be referred to one or the other.

IV.—On the Structure of the Roof of the Skull and of the Mandible of *Peloneustes*, with some remarks on the Plesiosaurian Mandible generally.

By C. W. Andrews, D.Sc., F.R.S. (British Museum, Natural History).[1]

IN the course of the preparation of the second part of the *Catalogue of the Marine Reptiles of the Oxford Clay* in the Collection at the British Museum, it has been necessary to examine in detail the structure of the skull and mandible of the Pliosaurs, especially of *Peloneustes philarchus*, several excellent specimens of which are included in the Leeds Collection. In the course of this examination several peculiarities have been observed, which on the one hand tend to reconcile the conflicting views as to the structure of the skull roof that have been put forward, and on the other serve to correct the interpretation of the elements of the mandible given in the first part of the Catalogue.

In the Plesiosaurian skull one of the most difficult points to determine is the precise position of the suture between the parietals and frontals, and the relationship of those bones to the pineal foramen. In *Murænosaurus*, *Cryptocleidus*, and *Tricleidus* this suture runs across the front of the pineal foramen, the parietal overlapping the frontal in such a way that while the former may completely enclose the foramen on the outer surface of the skull (as in *Murænosaurus* and *Cryptocleidus*), the frontals extend back beneath the parietals, and form the anterior border of the opening on the cranial surface. In the type-specimen of *Tricleidus seeleyi*, in which the various elements are disarticulated from one another, it can be seen that the anterior part of the border of the pineal foramen is formed by the frontals alone. In *Peloneustes* the arrangement of these bones is very different. In this case the forward extension of the parietals over the frontals anterior to the

[1] Published by permission of the Trustees of the British Museum.

pineal opening is much greater than the Elasmosaurs, and indeed is carried to such a degree that their anterior angle reaches the posterior ends of the facial processes of the premaxillæ, thus excluding the frontals from the middle line on the outer surface of the skull. On the cranial face (Fig. 1) it can be seen that the parietals meet in front of the pineal foramen (*p.f.*) and run forwards in the form of a wedge (*par.*) between the frontals, which, though excluded from the pineal foramen, run back as far as about the middle of that opening. In front of the ventral wedge-like prolongation of the parietals the frontals (*fr.*) appear to meet at least for a short distance in the middle line beneath them. The posterior region of the frontal unites extensively with the post-frontal (*po.f.*), which extends back to the

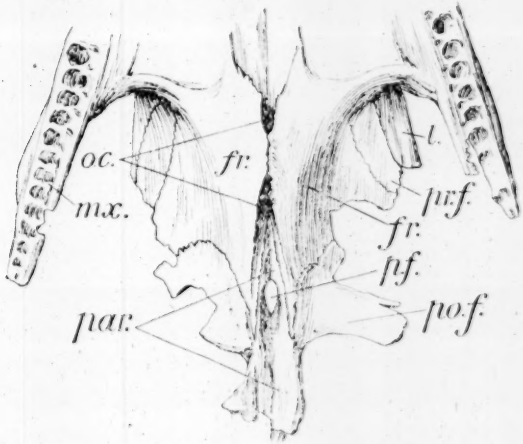


FIG. 1. Inner face of the middle portion of the skull roof of *Peloneustes philarchus*. (About one-third nat. size.) *fr.* frontals; *l.* lachrymal; *mx.* maxilla; *o.c.* channel enclosed by the downgrowths of the frontals; *par.* parietals; *p.f.* pineal foramen; *po.f.* post-frontal; *pr.f.* pre-frontal.

level of the middle of the pineal foramen, and has a short contact with the parietal; externally the post-frontal unites with the post-orbital. In front of the post-frontals the ventral surface of each frontal is raised into a high cristiform ridge, which curves downwards and inwards towards the middle line, where it just meets its fellow of the opposite side for a short distance, thus enclosing a deep channel (*o.c.*), probably for the olfactory nerves. Anteriorly these ridges die away a little in front of the anterior angle of the orbit. Antero-laterally the frontal unites with the pre-frontal (*pr.f.*), and these again on their outer side join the element which is here regarded as the lachrymal (*l.*).

Professor Williston,[1] in his account of the structure of the skull in

[1] *North American Plesiosaurs*, pt. i (Field Columbian Museum, Geological Series, vol. ii, No. 2 (1903), pl. iv, fig. 1). Also Proc. U.S. Nat. Mus., vol. xxxii (1907), p. 478, pl. xxxvii.

Dolichorhynchops osborni and *Brachauchenius lucasi*, both from the Cretaceous beds of Texas, describes the parietals as separating the frontals, and extending between them to meet the posterior ends of the facial processes of the premaxillæ. Possibly in these cases also the overlap of the parietals may be mainly superficial, and the frontals actually extend back to the level of the parietal foramen, in front of which they may either meet in the middle line on the inner surface of the skull, or at least be separated by a small interval only. If this is the case the structure of the skull in these American Plesiosaurs would fall into line with that seen in the European forms.

The Leeds Collection contains some very complete specimens of the mandible of *Pliosaurus* and *Peloneustes*, and examination of these, particularly of some belonging to *Peloneustes philarchus*, shows firstly that the structure of this part of the skeleton differs considerably from that occurring in the Elasmosaurs, and secondly that the description of the Elasmosaurian mandible given in the first part of the *Catalogue of the Marine Reptiles of the Oxford Clay* is wrong in several particulars, and I take this opportunity of making the necessary corrections.

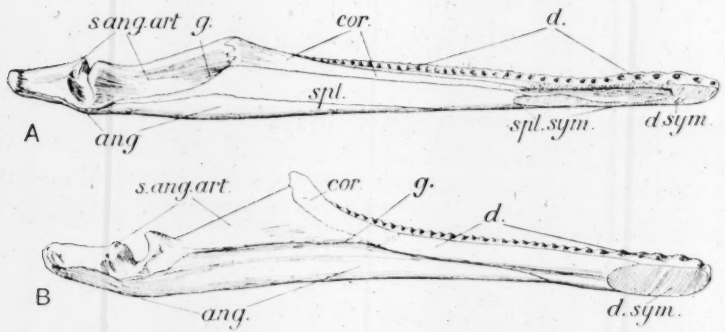


FIG. 2. Inner face of the left ramus of the mandible of (*A*) *Peloneustes philarchus* (about one-eighth nat. size) and (*B*) of *Murænosaurus* (a smaller specimen). *ang.* angular; *cor.* coronoid; *d.* dentary; *d.sym.* symphyses of dentaries; *g.* dental groove; *s.ang.art.* united surangular and articular; *spl.* splenial; *spl.sym.* symphyses of the splenials.

Each half of the mandible of *Peloneustes* is composed of five pieces. These are (1) the fused articular and surangular, (2) the angular, (3) the dentary, (4) the coronoid, (5) the splenial. Of these, as usual, the dentary (*d.*) is much the largest, extending from the coronoid angle to the anterior end of the jaw. It bears about forty teeth, of which about fourteen are in the symphysial region. The whole symphysial surface is formed by the dentary except a narrow ventral strip (*s.sym.*) formed by the extension forwards of the splenials. The anterior ends of the coronoids, though just extending into the symphysis, do not seem to have actually united with one another in the middle line. On the outer face of the jaw the posterior end of the dentary overlaps the surangular above and the upper part of

the angular below the complex suture between them running downwards from the coronoid angle. The lower part of the angular is prolonged forward beneath the dentary, forming the ventral border of the jaw, to a point a little behind the symphysis. On its inner face the upper part of the dentary is covered to a large extent by the closely adherent coronoid, which extends from the coronoid angle, in the formation of which it shares, to just within the symphysis, though, as already noted, it is doubtful whether the coronoids themselves actually united with one another. The coronoid (*cor.*) is in turn itself overlapped on its inner face by the splenial (*spl.*), which roofs in the dental groove (*g.*) and unites by its ventral edge with the upper border of the angular, fitting into a deep groove in the upper border of that bone posteriorly and overlapping it anteriorly, where it runs down and forms the ventral border of the jaw. At its anterior end the splenial extends some distance in to the symphysis, uniting with its fellow in the middle line (*spl.sym.*). At its posterior end it forms the inner and lower edge of the opening of the dental canal (*g.*), and extends back as a narrow strip of bone along the upper edge of the angular to a point only a little in front of the articular surface for the quadrate. The surangular and articular (*s.ang.art.*) are represented by a single element: this forms the upper part and the rounded posterior end of the post-articular process: it also bears the articular surface for the quadrate, consisting of an outer and an inner concavity. In front of this the upper border rises towards the coronoid angle, and is broad and flattened. At the coronoid angle the bone is overlapped on its outer side by the posterior end of the dentary, and on the inner side at the same level it joins the coronoid; the lower edge is united with the angular throughout. The angular (*ang.*) forms the whole of the lower part of the posterior half of the mandible, and it sends forward a prolongation, overlapped externally by the dentary and internally by the splenial, to within a few centimetres of the symphysis. Its upper edge is deeply grooved and forms the floor of the dental canal, and receives the lower edge of the splenial at least in the posterior portion of that bone.

In a species of *Plesiosaurus* from the Uitenhage Beds of South Africa the general arrangement of the elements of the jaw are very similar, except that the coronoid is much shorter and does not reach the symphysis, and it is doubtful whether the splenial does so either. In the Liassic Plesiosauria also the structure, so far as can be made out, is similar: in the longer-snouted forms at least the splenial extends into the symphysis. In the jaws of the Elasmosaurs of the Oxford Clay the case is different, and it is necessary here to correct some errors in the account of the structure of the lower jaw in these reptiles, given in part i of the *Catalogue of the Marine Reptiles of the Oxford Clay*, examination of the Pliosaurian mandibles and other material having thrown new light on the subject. In the account there given the coronoid is said to be entirely wanting, while the splenial extended from the coronoid angle to the symphysis, closely adherent to the inner face of the dentary above the dental groove. As a matter of fact the coronoid (Fig. 2, *B*), though lost in nearly all

cases, was present, and formed a prominent coronoid angle: at its posterior end it unites in suture with the surangular-articular, and extends forward for a short distance closely adherent to the inner face of the dentary: it is shown in text-fig. 48 of the Catalogue, where it is marked *spl.*; in the text-figure 46B it is nearly correctly shown, but is described as the coronoid process of the splenial. The splenial, so far as is known, is entirely wanting in the mandibles of *Muræenosaurus* and *Cryptocleidus*, in which the dental groove remains open throughout its length. In a specimen of the mandible of *Tricleidus* (*R.*) there are traces of a very thin layer of bone crushed down into the groove; this may perhaps represent the remains of a very thin splenial element. Of course, in *Muræenosaurus* and *Cryptocleidus* a similar structure may have been present and have been lost in the process of fossilization. The difficulty of determining the position of sutures in the more or less crushed mandibles which were examined must be the excuse for the error here corrected.

V.—The Neolithic Remains of Colonsay, in the Western Isles of Scotland.[1]

By W. B. Wright and the late Angus M. Peach.

I. Introduction.
II. Former Investigations in Colonsay.
III. The Colonsay Axe-heads.
IV. The Newly Discovered Neolithic Floor.
V. Description of the Flint Implements.
VI. Conclusions.

I. Introduction.

THE more exact investigation of the distribution and mode of occurrence of Neolithic remains has received a much needed stimulus from the publication of Professor Brögger's memoir[2] dealing with the position of the strandlines in South-Eastern Norway during the stone age of that country. It has been clearly demonstrated in this important work that it is possible to distinguish, even in the relatively short-lived Neolithic culture, certain phases of chronological value, and to correlate these phases, by means of the distribution of the implements which characterize them, with the successive stages in the elevation of the land which affected Scandinavia in postglacial times. It has become clear, therefore, that the careful registration and description of Neolithic relics may lead to the most important scientific results, and it will be realized by all who indulge in archæological collecting that an exact determination of the locality of any find and of the relations it bears to the superficial deposits of the neighbourhood, more especially to the old shorelines which border the coasts of the British Isles, is of the utmost importance.

It must not be forgotten, however, that in Scandinavia conditions were peculiarly favourable for such investigations. The amplitude of

[1] Published by permission of the Director of the Geological Survey of Great Britain.

[2] W. C. Brögger, "Strandliniens Beliggenhed under Stenalderen i det Sydöstlige Norge": Norges Geol. Undersögelse, No. 41, 1905.

the *Littorina–Tapes* depression, amounting in the Kristiania region to about 70 metres, gave opportunities for the exposure of wide areas of land during recovery, and so facilitated correlation with the distribution of the implements. In the British Isles the corresponding depression, that of the so-called '25-foot beach', was relatively trifling in amount. The difficulty of employing the recession of the shoreline as a means of dating the implements is therefore enormously increased. Nevertheless it has been found possible to make certain advances in this direction. As early as 1869 Du Noyer[1] showed that in the north-east of Ireland the gravels of the '25-foot' raised beach, which has there an altitude of 18 or 20 feet above the present shoreline, abounded in flint implements. He pointed out that these implements were of a rather rude type, and contrasted them with the more perfect forms found on the surface in various localities, the latter including beautifully shaped arrow or javelin heads with barbs. He concluded that the men who made the first-mentioned ruder implements lived during the formation of the raised beach, while the more perfect types he regarded as being indicative of much greater skill and as being later in age.

Doubt having been cast on Du Noyer's statement that the implements were actually contained in the gravel of the raised beach, a committee of the Belfast Naturalists Field Club was appointed in the year 1886 to make excavations in the famous raised gravel spit in Larne Harbour, county Antrim, with the object of putting this point to the test. The final report[2] of this committee, drawn up by R. Ll. Praeger in 1889, proved that near the landward end of the spit the gravel contained implements to a depth of 19 feet from its surface, that is, throughout almost its entire thickness, a fine example of a rude axe-head being found at a depth of 11 feet from the surface. More recently Messrs. Coffey & Praeger[3] have carried out a more extended series of investigations into the Neolithic deposits of the North of Ireland, and have succeeded in establishing the important fact that the elevation of the land which brought the beach into its present position was almost entirely, if not quite, completed during Neolithic times. This has been effected by a determination of the levels of the Neolithic floors in the sand-dunes which overlie the raised beach gravels of Whitepark Bay on the north coast of Antrim and Port Stewart in Londonderry. It has also been proved by them in confirmation of Du Noyer's idea of an earlier and later stage of culture that the industry at these sites is quite distinct in character from that of the Larne beach and of a more advanced type. The nature of the flaking is somewhat different and polished axe-heads have been found in all the localities examined, whereas those obtained from the Larne gravels never show any attempt at polishing.

It is very remarkable that the rough-hewn axe-heads of the Larne

[1] G. V. Du Noyer, "On Flint Flakes from Carrickfergus and Larne": Q.J.G.S., vol. xxv, p. 48, 1869.

[2] Proc. Belfast Nat. Field Club (2), iii, pp. 198–210, 1890.

[3] George Coffey & R. Lloyd Praeger, "The Larne Raised Beach, a Contribution to the Neolithic History of the North of Ireland": Proc. Roy. Irish Acad., vol. xxv, section C, p. 146, 1904.

raised beach gravels, called by Messrs. Coffey & Praeger the 'Larne type', are identical, if we neglect the difference of material, which is determined by local circumstances, with the axe-heads of 'Nostvet type' which Professor Brögger finds to be associated with the highest shoreline of the *Littorina–Tapes* depression in Norway. We must remember, however, that as Messrs. Coffey & Praeger point out, the Larne Spit was not a dwelling-place, but only a workshop, where the axe-heads may possibly have been merely roughed out and taken away to be finished elsewhere.

In the Isle of Man Mr. Lamplugh found that the worked flints were plentiful on the surface of the inner portions of the wide gravel platform of the raised beach, which has there an altitude of 10 or 12 feet above high-water mark, while they were absent except as rolled fragments on the seaward portions. He concluded that at any rate part of the platform was in existence and above sea-level in Neolithic times, but that it may not have attained its full breadth until after the close of that period.[1]

Coming now to Scotland we find several cases like that described by Mr. Lamplugh. In the famous sands of Luce the Neolithic remains occur in the landward part of the sandhills overlying the gravels of the raised beach, while in the seaward part of the dunes they are absent.

Where the River Avon enters the carse lands of the Forth is a series of kitchen middens, described by Dr. Peach, all of which occur either on the bluff which borders the carse or just at its base, as if, when it was the limit of high water, the people who formed the middens, after searching the shores during low water, had retreated thither to enjoy their feast while the tide covered their hunting-ground.[2] In this case, however, there is no conclusive evidence that the middens were made by Neolithic man, since no implements have been found in them. The fact that they occur at the foot of the cliffs shows that they are at least later than the '25-foot' maximum submergence.

A few other cases in which Neolithic remains can be shown to have a definite relation to former oscillations might be cited, but the above are sufficient to show that very definite and valuable results may be obtained by careful observation of the distribution and site of implements. It is proposed in the following pages to give an account of a Neolithic floor recently found in one of the Western Isles of Scotland under conditions which seem to indicate a higher level of the sea during its occupation; and at the same time to pass in review for the purpose of comparison such other Neolithic remains as have hitherto been recorded from the island.

II. Former Investigations in Colonsay.

The first indication of the former occupation of Colonsay by Neolithic man was the finding in the bed of Loch Fada, at the time when its surface was lowered by draining, of a finely shaped stone

[1] G. W. Lamplugh, "The Geology of the Isle of Man": Mem. Geol. Survey U.K., 1903, p. 403.

[2] Mem. Geol. Survey Scot., Explanation of Sheet 31, Edin., 1879, p. 54.

axe-head. This discovery is mentioned by Mr. Murray in the appendix to *Summer in the Hebrides*, where he states that "both stone and bronze celts have been found by the shore of Loch Fada in Colonsay", and adds that these may be seen in the Museum of the Society of Antiquaries, Edinburgh, marked A.F. 173 and D.A. 43. To the discussion of the stone axe-head we will return later, and pass on now to give some account of the researches of Mr. Symington Grieve and the late William Galloway, the results of which were published in the Journal of the Linnean Society in the year 1883.[1] These investigators made an exploration of the shell-mound or kitchen midden of Caisteal-nan-Gillean in Oronsay. This mound was composed largely of blown sand, but contained a stratum of shells having a thickness of about 8 feet at the centre. From this were obtained bones of the red deer, marten, otter, rat, pig, grey seal, common seal, great auk, and guillemot, as well as the following traces of man:—

1. Two bone harpoon-heads, one with opposite and the other with alternate barbs.
2. A bone awl in a perfect state and the point of another.
3. A number of bones, partly of red deer, rubbed at one end so as to give an edge; some of these were rubbed flat on both sides, others only on one.
4. Oblong water-worn stones of a slaty character, some with one end rubbed so as to form an edge.
5. A few oval and nearly round stones that showed marks of having been used for striking.
6. A few pieces of flint of small size and not obviously worked.
7. Some large flat stones with charcoal and burnt material around them, evidently hearthstones.
8. Some stone-heaters cracked by the action of fire.

Of these relics of human occupation only the water-worn stones (No. 4) call for further remark. They are merely elongated shingle stones picked up on the beach, and vary from 2 or 3 inches to quite a foot in length. The smaller ones, which were found near the hearths, bear marks of having been rubbed at one end, but the larger, which generally lay further out on the periphery of the mound, show, with the exception of being occasionally fractured at the ends, no trace of use. The employment among the islanders no very long time ago of similar stones as hammers for knocking limpets off the rocks suggested to Mr. Grieve a possible parallel use for those of the mound. Whether the smaller stones, which are rubbed down to an edge at one end, were employed for the same purpose as the larger ones, it is hard to say.

The deposits of the New Cave (Uamh Ur) on the south side of Kiloran Bay have also been studied by Mr. Grieve, but were found to be far less productive of objects of interest than the shell-mound of Caisteal-nan-Gillean. The strata, which only locally cover the shingle forming the floor of the cave, showed little variety throughout their thickness of 2 or 3 feet. The stalagmite was confined to the surface, and the deposit beneath consisted largely of charcoal and bones with layers of burnt clay and stones cracked by the heat. Remains of

[1] Symington Grieve, "Notice of the Discovery of Remains of the Great Auk or Garefowl (*Alca impennis*) on the Island of Oronsay, Argyllshire": Journ. Linn. Soc., Zoology, vol. xvi, p. 479, 1883.

a small variety of sheep and of the Celtic shorthorn (*Bos longifrons*) were abundant, and those of the horse were fairly common in the upper layers. In addition were found three bones of the pig and a single fragment of an antler of the red deer. The latter occurred in the base of the deposit. The only relic of human industry was the upper or eyehole end of a broken bone needle. The bones, however, showed traces of the presence of man, being split open and often calcined.

FIG. 1. Sketch-map of Colonsay and Oronsay on the scale of 3 miles to an inch, showing the positions in which the various Neolithic remains have been found.

From a comparison of this fauna with that of the Oronsay shell-mound Mr. Grieve draws the conclusion that the occupation of the cave was more recent than that of the mound. Thus the red deer, which is plentiful in the lower strata of the mound and persists throughout it, is represented only among the early deposits of the cave, and even there by a single fragment of an antler. The pig appears only in the lower deposits of the cave. The sheep, represented by one doubtful bone near the surface of the mound, occurs all through

the cave deposits, while the ox first shows evidence of its presence about the middle of the latter. The horse is only found in the very uppermost deposits.

The chief interest attaching to these archæological researches is the proof they afford us that the earlier inhabitants, those of Caisteal-nan-Gillean, were a hunting and fishing folk, and that later, at the period of occupation of the cave, they had either been replaced by or had developed into a pastoral race, possessing at first only sheep, but, at a later period, cattle and horses as well. It will, however, be noted that none of the implements are of a type to yield definite evidence of date, and it cannot with confidence be claimed that these deposits are any proof of the occupation of Colonsay by Neolithic man.

III. The Colonsay Axe-heads.

The axe-head referred to on p. 167 was found at the western end of Loch Fada by Archibald M'Connell, who, on the day of the completion of the cutting made at Kiloran to lower the surface of the lake, is said to have been cutting thatch at its upper end. During the early part of the day this necessitated his wading almost up to his waist, but returning to his labours after dinner he found that during his absence the workmen at Kiloran had cut through the final barrier and the surface of the water had fallen several feet. The spot where he had been working in the morning was now dry and the thatch could be cut without wading. While walking on the soft peaty lake-bottom thus exposed he put his foot on something hard, and, stooping to see what it was, picked up the axe-head. It lay practically on the top of the peat in which are embedded the stumps of trees which occur in many places round Loch Fada, even at a depth of several feet beneath its present surface.[1]

The axe-head, which can be seen in the National Museum of Antiquities of Scotland, labelled A.F. 173, is of a whitish weathered rock, 6½ inches long, 3½ inches wide where widest, and 1 7/8 inches thick where thickest. It tapers to a point at the haft end, and has a surface which is ground smooth but does not at present exhibit any polish.

Unfortunately the conditions of this find do not afford much evidence as to its geological date. If we could be certain that it actually lay on the old forest soil, and if we knew for certain what trees grew in the forest, we might fix its date with regard to the immigration of the trees. We have, however, no reliable information on either of these points. All we can say is that it affords evidence that Colonsay was once inhabited by a race of Neolithic men, who had reached a stage of culture considerably higher than that of the Larne gravels or the kitchen middens of Scandinavia and Denmark.

The other axe-heads from Colonsay are also preserved in the National Museum of Antiquities of Scotland. One of these, No. A.F. 419, was found in a ploughed field in Uragaig, Colonsay, in 1881. It belonged to the Galloway Collection and was purchased in 1898. Its dimensions

[1] In connexion with this account of the circumstances of the find, however, it must be noted that even with an excessive estimate of the size of the outlet and of the rate of flow in it the surface of the lake could not have been lowered anything like 2 feet in less than twenty-four hours.

are $5\frac{5}{8} \times 2\frac{3}{4} \times 1\frac{3}{4}$ inches. It is of a similar type to the Loch Fada axe, being pointed at the haft end. It is, however, somewhat thicker and of a darker stone. The other, No. A.F. 497, is a much larger axe of greenstone weathered very white but blue on fresh fractures. Its dimensions are $11 \times 4\frac{3}{8} \times 2\frac{9}{16}$ inches. It was found at Reasagbuie, about 1 mile north-east of Scalasaig, and was presented in 1906 by the Rev. B. Mackenzie. It is much weathered, but the uneven surface presents a pitted appearance as if it had been picked all over. The pitting may, however, be merely an effect of the weathering. The haft end is pointed as in the other two axes, but the body is very cylindrical, and a further difference is apparent in the rapid divergence towards the cutting edge, which is thus wider than any other part of the axe. The form is very similar to that of an axe of much the same size from Shetland which is figured in the Museum catalogue (No. A.F. 226).

All these axes taper to a point at the haft end and belong clearly to Brögger's point-necked ('spidsnakket') type. The surface has been ground smooth, but does not at present exhibit any polish. They are certainly not of an early Neolithic type, and, if Brögger's classification has anything beyond a local value, ought to belong to his 'Newer Stone Age', which immediately preceded the Copper and Bronze Age.[1]

IV. The Newly Discovered Neolithic Floor.

Flint implements showing obvious Neolithic workmanship were first collected in Colonsay by the authors in the years 1907 and 1908. They occurred in abundance on a well-marked floor in the sand hills north-east of Balnahard in the north end of the island. This floor lies from 200 to 300 yards back from the present beach at a height of 22 to 24 feet above high-water mark of spring tides (see Fig. 2); and it is remarkable that, except in the immediate neighbourhood of the floor where they have been let down by wind erosion of the underlying sand, no implements occur at a lower level than this, or anywhere in the more recent sand-hills near the shore. This relation is suggestive of a higher sea-level at the time of the occupation of the floor. A single case of the kind, however, cannot be said to be anything more than suggestive, and we have not found any other accumulations of obvious Neolithic implements in the island.[2] The difference in level between the modern and '25-foot' shores has been estimated at about 23 feet, but may be as little as 21, or as much as 25 feet. It is just possible that the floor may correspond in date to the '25-foot' maximum depression, but on the whole it is more probable from its position that it is somewhat later. The sand which forms the substratum is indistinguishable from that of the rest of the sand-hills,

[1] W. C. Brögger, "Strandliniens Beliggenhed under Stenalderen i det Sydöstlige Norge": Norges Geologiske Undersögelse, No. 41; Kristiania, 1905.

[2] We have found a small scraper at about the same level in the Kiloran sand-hills and two worked fragments of flint on the surface of the '25-foot' beach in Port nan Fliuchan (Uragaig), as well as some rude chips on the links near Machrins. The latter are not obviously Neolithic, and none of the other cases are good enough to give much assistance.

but it would be difficult to say whether it is really blown sand or merely the upper portion of the old sandy shore.

The floor in which the implements lie is firmly cemented by oxide of iron, which pipes down into the subjacent sand in a remarkable way. The flint chips lie scattered about in all directions, and do not appear to be accumulated in one spot more than another. There was certainly no trace of anything in the nature of a mound, and no marked accumulation of shells or bones. We saw neither hearth-stones, nor heaters, nor any other indication of a fire having been lighted on the spot. In fact, it is exceedingly unlikely that the floor as at present exposed was in any sense a dwelling-place.

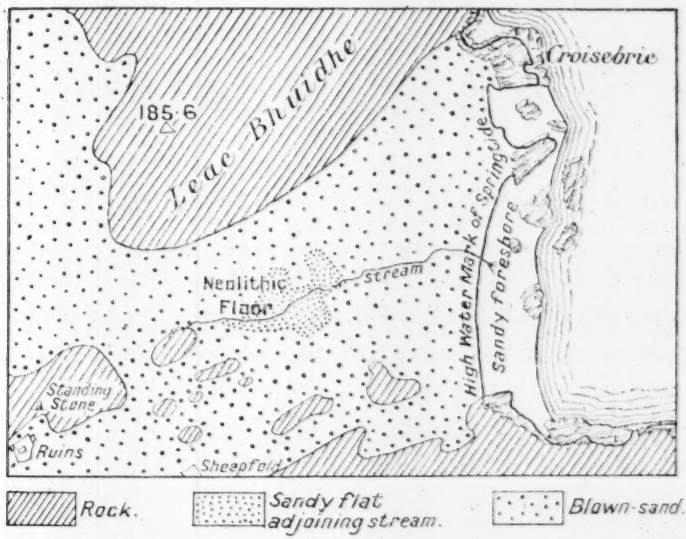


FIG. 2. Sketch-map of the Sand-hills at Balnahard on the scale of 6 inches to a mile, showing the position of the Neolithic floor.

The only objects of interest found on the floor in addition to the numerous flint flakes were some elongated water-worn shingle stones with rubbed or broken ends. These are merely fragments of the Torridon mudstones of the island, the cleavage in which frequently causes them to break up into elongated pieces, which become rounded on the shore. The ends of some of these stones are distinctly bevelled by rubbing, and others are broken in such a manner as to suggest that they have been used with considerable force. In the presence of these stones we have a suggestion, but only a suggestion, of contemporaneity with the shell-mound of Caisteal-nan-Gillean, where exactly similar implements have been found in considerable numbers[1] (see p. 167).

[1] Mr. T. C. Cantrill informs me that he has found a number of such elongated pebbles, averaging 6 inches in length, on flint chipping-floors in Pembrokeshire, and believes they are flaking-tools.

V. Description of the Flint Implements.

The flint implements found on the floor are on the whole rather rude, and few of them indicate any great skill in the manufacture. A large majority are merely flakes struck from a core and exhibit little or no secondary working. The cores themselves are not uncommon, but like the flakes are generally of small size. They frequently retain some portion of the original rounded and battered surfaces of the beach pebbles from which they have invariably been made. The material of these beach pebbles must have been rather intractable, having long lost any traces of quarry water, and the quantity available for selection was by no means large. Occasional flint pebbles can be found in the shingle beaches round the island, but they are certainly not at all common. The shore in the immediate neighbourhood is not composed of shingle, and the pebbles must therefore have been carried to this spot from other parts of the island. In describing the different types of implement found we will take them in order under the following heads :—

1. Cores and simple flakes.
2. Secondarily worked chisel-ended flakes.
3. Secondarily worked cutting-edged flakes or knives.
4. Notched flakes.
5. Pointed implements.
6. Scrapers.

Fig. 3. Small core, Neolithic floor in Sand-hills, Balnahard, Colonsay. Nat. size.

1. The predominant type of core is of conical form, the flaking having being effected from the base of the core towards the apex (see Fig. 3). The greater number of flakes thus produced are prismatic in form, but, when the fracture failed to run the full length of the core, pointed flakes were also produced. The majority of the flakes are triangular in section, narrow, and long, but broader flakes with a four-sided cross section are not uncommon (see Fig. 4, A), the latter being almost without exception the flakes which have been selected for further development by secondary working. The cores found had been reduced to a small size, as if there were a distinct demand for the minutest flakes.

2. Of the flakes showing secondary working the most simple types are those which have been chipped at one end with the evident intention of making a chisel-like tool. In all these the secondary chipping is at the bulb end of the flake and on the off side from the bulb, so that the latter forms, so to speak, part of the flat side of the chisel (see Fig. 5). The presence of the bulb on this flat side was

obviously a disadvantage, for in many cases attempts have been made to remove it, or at least reduce its convexity by striking small flakes off its apex (Fig. 5). It is hard to say why, in view of this disadvantage, the bulb end is constantly chosen for bevelling. This seems, however, to be a character of many of the flakes in the famous collections from the Culbin sands and Luce Bay in the Museum of the Society of Antiquaries. Attempts to remove the bulb are not, however, so marked in these cases. The explanation of the use of the bulb end may possibly lie in the knowledge that the worker possessed of the temper of the flint at that end, where he had already struck it. The Colonsay floor has yielded a considerable number of flakes with the bulb end re-worked, whereas we have succeeded in finding only a single flake with secondary chipping at the opposite end, and this one is actually worked at both ends.

3. Among the secondarily worked flints are several of rather varied shape which have their edges adapted for cutting or sawing.

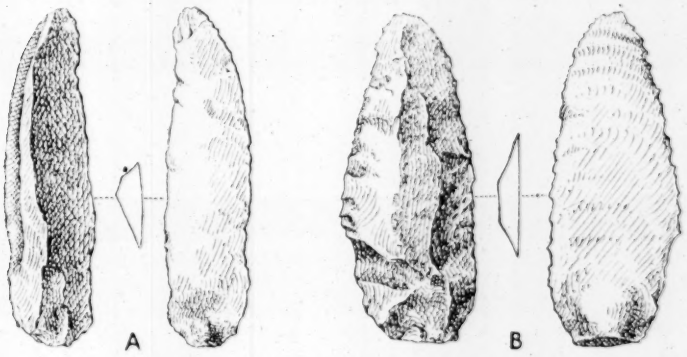


FIG. 4. Flint "knives" from Neolithic floor in the Sand-hills at Balnahard, Colonsay. *A*. simple flake from core; *B*. flake with secondary working. Nat. size.

The flakes used for this purpose all have one side flat and formed of a single face of fracture, while the other is convex with several faces. The secondary flaking by which the saw edge has been obtained has all been done from the flat-side towards the convex side, the result being a certain amount of bevelling similar to that of the chisel-shaped scrapers above described, but extending right along one or both edges of the flake. A good example is shown in Fig. 4, B.

4. Among the more uncommon types are a few notched flakes which had obviously a very special use, such, for instance, as scraping bowstrings. A natural nick in the flint has usually been taken advantage of and enlarged by secondary chipping, so as to produce a small crescentic bevel edge. The remaining edges of such a flake may also show secondary chipping, as if it had served as well for a saw or knife.

5. Apart from a number of flakes which possess a point as a consequence of the accidental intersection of faces produced when

they were struck from the core, a very few pointed implements were found. Only one obvious arrow-head (Fig. 6) has come to light, but this, if we take into consideration the intractable nature of the flint, shows a very fair amount of skill in the manufacture. Both sides of the flakes have been worked so as to produce a symmetrical edge, and the chipping is in places quite regular. One very perfect barb has been produced, but the other appears to have broken off in the making, a fact which probably accounts for the arrow-head having being left in the factory. A distinct tang had, however, been roughed out before the flake was abandoned.

6. Among the conical core-like flints referred to above are a few which are so low that the flakes struck from them cannot have been more than a quarter, or in some cases an eighth, of an inch in length. Such minute flakes may of course have been used for tipping arrows, but on the other hand they may merely have been removed with the object of fashioning the core itself into a bevel-edged scraper. There

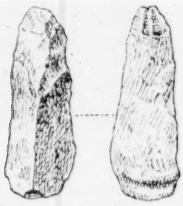


FIG. 5. Flake from core modified into chisel-shaped scraper by secondary working at the bulb end. Neolithic floor in Sand-hills, Balnahard, Colonsay. Nat. size.

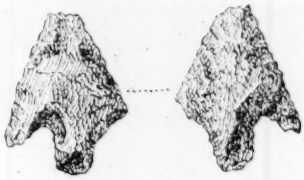


FIG. 6. Flint arrow-head from Neolithic floor in the Sand-hills at Balnahard, Colonsay. Nat. size.

are also in the collection several small more or less circular lenticular flakes with obvious secondary working, to which it is difficult to assign any other use than that of scrapers.

VI. Conclusions.

Unfortunately none of the flint implements described above are of sufficiently well-defined character to be referred with confidence to a definite phase of Neolithic culture. It is impossible even to say whether they are early or late Neolithic. Their roughness may be in part due to want of skill, but on the other hand it certainly is to some extent the result of the inferior nature of the material employed. Taking into account this latter factor the single arrow-head which has come to light cannot be regarded as ill-formed, though, of course, it will not bear comparison with the beautiful implements of Yorkshire and other districts where better material was obtainable.

The axe-heads found in various parts of Colonsay are more obviously of a late Neolithic type, but as regards their geological date we have not even such slight evidence as is forthcoming in the case of the flint implements. The other prehistoric remains of the islands have very little chronological value. Hoernes[1] draws a comparison between

[1] Moriz Hoernes, *Der Diluviale Mensch in Europa*; Brunswick, 1903.

the implements of the Oronsay shell-mound and those of the Asylien and Arisien of France. These names have been given by Piette to strata occurring in the cave of Mas d'Azil between deposits of the Reindeer Period and purely Neolithic deposits with polished axe-heads. The Asylien yields flat harpoon points of stag's horn to which those of Oronsay bear a considerable resemblance. In the overlying Arisien, and also in the still higher purely Neolithic strata, there occur pebbles and slabs of slate, which are polished to a cutting edge either at the end or at one side. These implements are regarded by Piette as foreshadowing the polished axe-heads of the Neolithic Period. The bevel-ended pebbles of Oronsay and of the Balnahard Neolithic floor in Colonsay certainly bear a resemblance to these, but, even when taken in association with the occurrence in Oronsay of the Asylien type of harpoon-head, they can hardly be regarded as sufficient evidence of an early stage of Neolithic culture in the islands.

Finally, the evidence of the connexion of the Neolithic floor of Balnahard with a higher level of the sea is of a negative kind, and could not stand by itself. Were it not that a similar relation is observable in other parts of Scotland and Ireland, no special significance could be attached to it.

NOTICES OF MEMOIRS.

The Jurassic Flora of Sutherland.

UNDER this title Professor A. C. Seward has given a general account of Scottish Jurassic plants, most of which have been obtained from Sutherland, and a particular account of the flora of the Upper Oolites of that county, based on materials collected by the late R. Marcus Gunn, F.R.C.S. (Trans. Roy. Soc. Edin., vol. xlvii, pt. iv, 1911). The formations from which plants have been obtained in Sutherland are: (1) Lower Oolites, including the Brora Coal Series of Great Oolite age, and possibly beds of Inferior Oolite, as suggested by Miss Stopes; (2) the Corallian Sandstone of Clyncleish Quarry, Brora, which has yielded in abundance casts of Cycadean stems described by Mr. Carruthers under the names of *Bucklandia* and *Yatesia*, but placed under the former genus by Professor Seward; (3) the Upper Oolites, between Kintradwell, north of Brora, and Helmsdale, Navidale, etc. The specimens in the collection of Mr. Gunn were obtained by him almost wholly from this last series, and mainly from Culgower Bay, in beds of Kimeridgian age.

The new forms described by Professor Seward are as follows:—

PTERIDOPHYTA.

FILICINEÆ.

Hausmannia Richteri.
Gleichenites Boodlei.
Marattiopsis Boweri.
Rhizomopteris Gunni.
Sphenopteris onychiopsoides.

GYMNOSPERMÆ.

GINKGOALES?

Phœnicopsis Gunni.

CONIFERALES.

Araucarites Milleri.
Masculostrobus Zeilleri, gen. et sp. nov.
Taxites Jeffreyi.

CYCADOPHYTA.

Pseudoctenis crassinervis, gen. et sp. nov.

These and other species are figured in ten plates and fourteen text-illustrations.

In his conclusion Professor Seward remarks: "It is generally agreed that the differences between Wealden floras and those from different horizons in the Jurassic system are comparatively small. It may be said without exaggeration that from the Rhætic and Liassic periods to the end of the Jurassic period, including the Wealden, the vegetation of Europe experienced no very striking or fundamental change . . . The Culgower flora has many features in common with the Upper Jurassic (Wealden) flora of Spitzbergen, the Wealden of England, Germany, and other regions, as also with the older Jurassic flora of East Yorkshire, which may be taken as a type of Middle Jurassic floras in various parts of the world. As one would expect in a flora of Kimeridgian age, we find an admixture of Wealden or Upper Jurassic, Middle, and Lower Jurassic species."

REVIEWS.

I.—A Monograph of the Terrestrial Carboniferous Arachnida of Great Britain. By R. I. Pocock. Palæontographical Society, in volume for 1910. 4to; pp. 84, 3 plates, and 42 text-figures. London, 1911.

IT is a matter of common complaint among zoologists that fossil animals, especially Invertebrates, are too often described by writers who have an insufficient knowledge of recent animals and of the literature referring to them. It cannot be denied that there is sometimes ground for this complaint, but, on the other hand, it must be admitted that there is justice in the palæontologists' reply that those who possess the necessary knowledge of recent animals can rarely be persuaded to take up the difficult study of their fossil remains. It is to be noted, further, that the scientific study of any group of fossils demands not only the broad outlook of the morphologist, but also the minutely detailed knowledge of the systematic specialist, since the necessary imperfections of fossil remains often leave only the most trivial and superficial characters from which to draw conclusions as to affinity; and it is just the systematic specialist who is least often ready to appreciate the scientific importance of palæontological research.

Mr. Pocock is recognized as one of the foremost authorities on recent Arachnida, and he has already made several noteworthy contributions to our knowledge of some of the fossil representatives of the group. Of the Monograph under review it is no exaggeration to say that it places the study of the Carboniferous Arachnida on a new footing, and it merits the attention of palæontologists and zoologists alike.

In all, thirty-three species are described, but, as the author very justly remarks, the species themselves are of very little importance in the present state of our knowledge, and more attention is given to discussing the characters and affinities of the Orders, families, and genera to which they are referred. A large proportion belong to the

Anthracomarti, an extinct group formerly included in the Opiliones, but regarded by Pocock as a distinct Order. The Phalangiotarbi are also given ordinal rank, and a new Order, Haptopoda, is established for a species to which the name *Plesiosira Madeleyi* is given. It is pointed out that these three Orders may possibly "serve to bridge, to a certain extent, the interval between the Opiliones and the more primitive Orders of Arachnida".

The other Orders represented in the Carboniferous fauna are the Scorpiones, Pedipalpi, Araneæ, Ricinulei, and perhaps also Opiliones. So far as the evidence of the fossils goes, the members of these Orders seem to have resembled, to a remarkable degree, those existing at the present day, and they serve to illustrate once more the extreme antiquity of living types of invertebrate animals. A few of the forms, however, show characters of great morphological interest, the most striking being those presented by a scorpion to which the name *Eobuthus Holti* is given. In addition to some peculiarities, of which the significance is not quite clear, in the region of the genital somite, this scorpion differs from nearly all those hitherto known in having the ventral plates of the fourth, fifth, and sixth somites of the abdomen each with the hinder margin divided into two semicircular lobes overlapping the succeeding somite. As Mr. Pocock points out, these bilobed overlapping plates have "a general resemblance to the gill-bearing appendages of the same segments in *Limulus*", and, as he was unable to find any trace of stigmata upon them, he concludes "that the respiratory lamellæ lay beneath them as they do in *Limulus*". He remarks that "in possessing these lobate sternal plates the Scorpion now described is more like *Limulus* than is the Silurian Scorpion *Palæophonus*". It is quite possible, however, as Mr. Pocock himself suggested in describing the Scottish Silurian Scorpion some years ago, that the supposed mesosomatic 'sternites' of *Palæophonus* are really broadly laminate gill-bearing appendages, as they have been shown to be in *Eurypterus*. If this should prove to be so it would reduce the difference in this respect between *Eobuthus* and *Palæophonus* to the fact that in the former the appendages are lobate as in *Limulus*, while in the latter they are square-cut as in *Eurypterus*. At all events there can be no question as to the extreme interest and importance of *Eobuthus* from this point of view, and it is to be hoped that collectors will be induced to keep a look out for more perfect specimens which will throw further light on its structure.

W. T. C.

II.—The Zones of the Chalk in Hants. By C. Griffith, M.A., F.G.S., and R. M. Brydone, B.A., F.G.S. 8vo; pp. 36, with 4 plates. Dulau & Co., 37 Soho Square, London, W., 1911. Price 2*s*.

FOR more than twenty years Mr. Brydone has been studying the Chalk of Hampshire and its fossils, at first while a pupil at Winchester College under the guidance of Mr. Griffith, and afterwards in collaboration with him. The present work, while embodying the results of their joint labours, has been drawn up by Mr. Brydone.

We have also before us the neat little booklet prepared in 1891 by Mr. Griffith for the Winchester College Natural History Society, and

a comparison between the lists of fossils then published and those in the pamphlet just issued shows how much has since been accomplished. For example, the number of Sponges recorded has been increased from 6 to 20, and of Echinoderms from 39 to 52; while among Cephalopoda, the species of Ammonites (still happily recorded under that generic name) have been increased from 5 to 13—the *Ammonites Bravaisianus*, d'Orb., of the older list being now recorded as *A. Neptuni*, Gein., as notified in Mr. Jukes-Browne's *Cretaceous Rocks of Britain*, vol. iii, p. 469.

A very great deal of additional information is now given with regard to the Chalk zones, and especially to the sub-zones of the *Actinocamax quadratus* zone, "which are capable of being separated all through the county." The following are the palæontological divisions adopted:—

Belemnitella mucronata.
Actinocamax quadratus, sub-zones—
Actinocamax quadratus.
Offaster pilula.
Echinocorys scutatus, var. *depressus.*
Marsupites testudinarius.
Micraster cor-anguinum, with *Uintacrinus*-band at top.
M. cor-testudinarium.
Holaster planus.
Terebratulina 'gracilis'.
Inoceramus labiatus and *Rhynchonella Cuvieri.*
Actinocamax plenus.
Holaster subglobosus.
Ammonites varians and *Rhynchonella Martini.*
Plocoscyphia labrosa and *Stauronema Carteri.*

The authors have endeavoured to visit every chalk-pit in Hampshire, and they have zonal records of about 180 sections. Mr. Brydone hopes shortly to publish a zonal map of the county. In the full list of fossils now printed references are given to the particular pits or other exposures where the zones have been identified.

In Appendices the authors contribute definitions and figures of the several forms of *Bourgueticrinus* found in the Hampshire Chalk, and known under the specific names of *B. ellipticus* and *B. æqualis*. They likewise describe and figure some varieties of *Echinocorys scutatus*. The illustrative plates are excellent. Dr. F. L. Kitchin also describes *Thecidea Brydonei*, a new species from the zone of *Belemnitella mucronata*. This is figured in the text

III.—Physical Geography for Schools. By Bernard Smith, M.A., F.G.S. pp. viii, 190, with 222 illustrations. London: Adam and Charles Black, 1910. Price 3*s*. 6*d*.

THIS work may be described as a concentrated essence of Physical Geography. Parts i and ii contain brief but concise accounts of the Solar System, the earth, its seasons, tides, and main features, of the atmosphere, climate, and geographical distribution of plants and animals on land and in water. The larger portion of the work, nearly four-fifths of it, is given up to the composition, structure, and erosion of the land, and the origin of the physical features: subjects appropriately dealt with by one who has gathered knowledge abroad, as well as in this country where he has been actively engaged for some years on the Geological Survey.

As examples of the illustrations we may mention Turf-cutting in Donegal; Anticline in Coal-measures, Saundersfoot, Pembrokeshire;

Earth Pillars in the Tyrol; High Force, Teesdale; Over-deepened Valley due to Glaciation, Ross-shire; Trent Bore at Gainsborough; and the Great Barrier Reef, East Australia.

The variety of topics which had to be treated in a limited space has tended to render too meagre some of the explanations and definitions, as in the case of dry Chalk valleys (p. 100), while a little more might have been said in description of such features as tundras and steppes. With reference to the latter the picture of the Kirghiz Encampment recalls to mind some of the desolate habitations in the Hebrides. In the definitions of shingle and gravel (p. 35) we should have indicated the more pebbly nature of the former, compared with the mixed and subangular character of the latter. The size of the stones is not usually regarded as a distinction, when we bear in mind some of the glacial 'cannon-shot' gravels. These, however, are trifling criticisms. The author has given so much information admirably expressed and illustrated, that not only students and teachers, but general readers who take interest in scenery will be glad to learn about the modes of sculpture of mountain, hill, and valley, of the varied origin of lakes, the development of rivers, the circulation of water underground, the formation of soils, and the many other subjects explained and discussed in this attractive volume.

IV.—Brief Notices.

1. London Springs and Spas.—In a work entitled *Springs, Streams, and Spas of London: History and Associations*, by Alfred Stanley Foord, 1910, the author has given a full and interesting account of the courses of the old (now buried) rivers and of the various noteworthy springs that supplied ordinary shallow wells and pumps, holy wells, and spas or mineral-water establishments. The conduit system of water-supply is described, and a few particulars are given of artesian wells. There are analyses of some mineral waters, and illustrations of Islington, Beulah, Streatham, and other spas, also of conduit-houses and old pumps. The geological features in connexion with springs and wells likewise receive attention.

2. The Glacial Geology of Norfolk and Suffolk is the title of a small work by Mr. F. W. Harmer (Jarrold and Sons, 1911, price 1s. net). The essay, which has been reprinted from the Transactions of the Norfolk and Norwich Naturalists' Society (vol. ix, pt. i, 1910), comprises an account of the North Sea Drift (Cromer Till and Contorted Drift) and of the Great Eastern Glacier that led to the formation of the Chalky Boulder-clay. The various Glacial Sands and Gravels are likewise described, and remarks are made on the origin of the valleys of Central Norfolk. The work contains, in fact, an interesting account, without tedious detail, of the Glacial period as it affected Norfolk; and it is illustrated by a contour map showing the distribution of the Drift and several pictorial views.

3. An account of Experiments with 'Water-finders' has been contributed by Professor J. Wertheimer to the Journal of the Royal Society of Arts (vol. lix, February 24, 1911). Experiments were made to ascertain the position of a well in the kitchen of Brislington

Hall. In this case the indications given by three experienced 'dowsers' were "absolutely at variance with one another", and the actual site of the well was not ascertained. We hardly think the test was a good one, because the well has a constant supply of water, and it is not improbable that the underground water extends beneath the whole area. Other experiments were made in different localities; in one case in reference to a drain, with an abundant flow of water, a few feet from the surface; in another case above a 3 inch water-main, the water being turned on and off at irregular intervals. The results showed that no dependence could be placed on the indications of the divining-rod. Again, experiments made to find gold and silver coins placed beneath saucers and cushions showed conflicting results.

4. The Fossil Horse of Bishop's Stortford forms the subject of a short article by Mr. E. T. Newton (*Essex Naturalist*, vol. xvi, p. 132, February, 1911). Attention was drawn in 1909 by the Rev. Dr. A. Irving to the discovery of the entire skeleton of a horse at a depth of 2½ feet from the surface at Bishop's Stortford. Dr. Irving was disposed to regard the remains as of Neolithic or Bronze Age, and Professor J. C. Ewart drew attention to resemblances between the Bishop's Stortford horse and examples from Walthamstow, believed to be of about the same approximate age. The horse of Bishop's Stortford, however, was larger, and Mr. Newton observes that the bones "present no characters which would indicate their being of prehistoric age; on the contrary, their agreement with the bones of modern horses points rather to a much more modern origin".

5. Western Australia. — Bulletin No. 36 (1910), issued by the Geological Survey of that country, contains an interesting series of "Palæontological Contributions". Dr. G. J. Hinde describes the Fossil Sponge Spicules in a rock from Princess Royal Township, Norseman District. The specimen, a soft white siliceous rock, was found to consist almost entirely of the spicular remains of siliceous sponges, with no traces of other organisms. In age it is probably newer than Cretaceous. Dr. Hinde remarks that "Besides spicules which resemble those of existing sponges, there are many in the deposit closely similar to detached spicules in material dredged from a depth of 3,000 fathoms off the south-west coast of Australia, and also to the spicules in the fossil sponge deposit at Oamaru, New Zealand, which is considered to be Upper Eocene in age". Other spicules belong to species found in European Cretaceous rocks. The rock was probably formed in the open ocean and at a considerable depth.

Mr. E. A. Newell Arber describes some fossil plants, *Otozamites Feistmantelii*, Zigno, and *Pagiophyllum*, indicative of the occurrence of Jurassic strata near Mingenew and Mt. Hill in Western Australia.

Mr. R. Etheridge gives an account of Oolitic Fossils from the Greenough River District. They include the following European species: *Serpula conformis*, Goldf., *Rhynchonella variabilis*, Schloth., *Alectryonia Marshi*, J. Sow., *Ctenostreon pectiniformis*, Schloth., *Pecten* (?) *cinctus*, J. Sow., and *Trigonia Moorei*, Lyc. New species of *Modiola*, *Cucullæa*, *Ostrea*, *Pleurotomaria* are described and

figured by Mr. Etheridge. Mr. L. Glauert contributes particulars relating to *Sthenurus occidentalis*, with illustrations; a list of Western Australian fossils; notes on new fossils (Devonian) from the Napier Range, Kimberley; and remarks on the geological age of the Gingin 'Chalk', which is Cretaceous.

Bulletin No. 38 (1910) consists of a well-illustrated report on the Irwin River Coal-field, by Mr. W. D. Campbell. This contains not only an account of the Carboniferous and Permo-Carboniferous strata, but also of the newer and older rocks of the district, and notes on diatomaceous deposits, gypsum, cave guano, and salt.

REPORTS AND PROCEEDINGS.

Geological Society of London: Annual General Meeting.

1. *February* 17, 1911.—Professor W. W. Watts, Sc.D., M.Sc., F.R.S., President, in the Chair.

The Reports of the Council and of the Library and Museum Committee, proofs of which had been previously distributed to the Fellows, were read. The total number of Fellows on December 31, 1910, was 1,299, being an increase of 5 during the year. No losses had occurred in the Lists of Foreign Members and Foreign Correspondents during the year.

The Balance Sheet for that year showed receipts to the amount of £3,159 17*s.* 2*d.* (excluding £100, the amount of the Hannah Bequest, and the Balance of £178 18*s.* 2*d.* brought forward from 1909), and an Expenditure of £2,985 16*s.* 2*d.*

The Report having been received, the President handed the Wollaston Medal, awarded to Professor Waldemar Christofer Brögger, F.M.G.S., to His Excellency Benjamin Vogt, Minister Plenipotentiary for the Kingdom of Norway, addressing him as follows:—

Your Excellency,—It is most fitting that the medal which bears the honoured name of Wollaston, and was founded by that eminent and philosophical mineralogist, should be awarded to Professor Brögger, who is not only an accomplished chemist and a skilful mineralogist, but a great petrologist. If he had published nothing but his work on these subjects, he would stand in the first rank of living geologists. But he has done far more. His researches on the Cambrian and Ordovician rocks of his own country have proved him to be a brilliant palæontologist and stratigrapher. His detailed mapping and interpretation of the structure of the Christiania area and his explanation of the origin of the Christiania Fjord, have proved him to be a tectonic geologist of the highest order. His researches on the differentiation of rock-magmas have made him one of our foremost teachers of petrogenesis. He has conducted an exhaustive research on the Glacial and post-Glacial changes in Southern Norway, and has expressed his results so cogently that we seem to see with our own eyes the ice-sheets retreating, the seas advancing and retiring, and to feel the climate slowly changing during the deposition of the clays and shell-gravels of your country. He has brought his work on the strand-lines into touch with the ages of man, and has even endeavoured to express these later stages of geological time in terms of years. Nor has his lifework been devoted to science alone; he has served his fellow-countrymen as a member of the National Legislature and his colleagues as the Rector of his University.

But it is not so much the quantity as the quality of Professor Brögger's work that constitutes his claim to the Wollaston Medal. His scientific training has

been so thorough, his insight so deep, and his outlook so wide, that in every subject which he has touched his work has become a mine of fact, a model of expression, an example of close and accurate reasoning, and a revelation of new principles. In an age of specialization he is a specialist, but a specialist in almost every branch of his science. That it should have fallen to one man to do so much and so well almost passes belief, but our libraries are enriched by his books and memoirs, and the work of our young men is inspired, improved, and encouraged by his example.

We ask your Excellency to transmit this Medal to Professor Brögger, and with it to convey to him the deepest respect of his British colleagues, and the best wishes of his many friends in this country.

The Norwegian Minister expressed his pride and pleasure in receiving on behalf of his distinguished countryman and friend the highest award which it was in the power of so venerable and learned a Society to confer, and read the following communication which had been sent to him by Professor Brögger:—

"Twenty years ago the Geological Society of London did me the great honour to award me the Murchison Medal. The Society now having awarded to me its highest honour, the Wollaston Medal, I am led to hope that also during the two decenniums that have elapsed, I have been able to yield some contribution of general interest to geological science.

"Allow me on this occasion to assure you that no other appreciation could have been more unexpected or more valued by me than the unanimous award of the Wollaston Medal by the Council of the Geological Society, an honour so surprising to me that even in my dreams I could never have expected to attain it. I am therefore so much the more grateful for this kind valuation of my scientific results.

"The roll of the Wollaston Medal, from the time of its first recipient, the great master, William Smith, until this day, comprises an unsurpassed series of founders and constructors of various branches of geological science. Looking on this roll, comprising also a number of those who were my valued instructors in my youth—the few still living amongst them being now seniors and Nestors of their science—I obtain an excellent scale of the high importance of such an appreciation from the oldest and most renowned Geological Society of the world.

"At the same time, these dear old illustrious names on the roll speak to me as a sad and serious memento of the short lifetime that is left, a reminder to devote the few years that may still remain for me to complete my main lifework, *The History of the Eruptive Province of the Kristiania Region*, the finishing of which, by the force of circumstances, has been interrupted and postponed by official duties for several years.

"Respectfully thanking you for this precious memento, I bow my head, and will do my best to follow its voice.

"W. C. Brögger.

"Kristiania, *February* 9, 1911."

The President then handed the Murchison Medal, awarded to Mr. Richard Hill Tiddeman, M.A., to Professor E. J. Garwood, Sec.G.S., for transmission to the recipient, and addressed him in the following words:—

Professor Garwood,—Ever since the beginning of Mr. Tiddeman's work for the Geological Survey on the borders of Yorkshire and Lancashire, he has kept his eyes open to the observation of exceptional facts and his mind employed in working out explanations for them. Thus he has endowed our science with the fertile suggestions which make workers think on new lines. The excavation of the Victoria Cave, with which he had so much to do, gave us valuable information on the history of the Pleistocene Mammalia; his work

on the glaciation of North Lancashire still remains "a model and a basis for Glacial work all over the country"; his observations on the faunas of the Carboniferous 'reef-knolls' of the North of England have put on record a wealth of observation and reasoning which will contribute no little to the solution of the problems presented by those remarkable structures; and his researches upon the raised beaches of Gower covered with Glacial deposits have extended the area of known Pleistocene movement beyond Yorkshire and Cork. Those who have been with him in the field have good cause to be especially grateful to him for the generosity with which he has placed the riches of his knowledge at their disposal. He has helped not only to advance geology but to make geologists, and in so doing has invested his talent at compound interest.

As a member of the Geological Survey, and one of the last of that body who served under Sir Roderick Murchison, he has well merited the award of the medal which bears that honoured name.

Professor Garwood expressed deep regret, which he felt was shared by all present, that a sudden attack of influenza had prevented the recipient from attending in person, and read, in accordance with Mr. Tiddeman's request, the following reply:—

"The award has given me the greatest possible pleasure and satisfaction, and I owe to the President and Council my warmest thanks.

"I regret that I have not done more to merit it; but I hope that I may take the award as signifying that some of my former heresies have been more or less accepted as orthodoxies by my present friends and colleagues, and for this I may go on my way rejoicing.

"R. H. Tiddeman."

In presenting one of the two Lyell Medals, awarded this year, to Dr. Francis Arthur Bather, F.R.S., the President addressed him as follows:—

Dr. Bather,—To devote one's self to the mastery and elucidation of a single group of organisms, and that a large one, demands in most cases so close an application to the study that neither time nor energy is available for other studies or occupations. This, however, has not been the case with you. Outside your own special orders of the Echinoderma, you have dealt with several other groups of the Invertebrata, and have been entrusted with the writing of the British Museum Handbook on the fossil members of this division of the animal kingdom. You have paid attention to the phenomena of denudation by wind as well as to general stratigraphical questions. You have travelled far and frequently in the pursuit of your comparative study of the Foreign and Colonial Museums, and have contributed much information and many valuable suggestions on Museum management, organization, and arrangement to your colleagues in this work. You have brought your ideas and methods for the popular exposition of Geology before the public at the recent International Exhibitions in London, and in more than one case have been exceptionally successful in achieving your objects. You have made yourself a recognized authority on zoological nomenclature.

But these are all by-products. You have ever kept before your mind the steadfast resolve to bring into order, to systematize and classify, and to describe clearly, faithfully, and precisely, certain important fossil forms of the Echinoderma, and especially the Crinoids. I would particularly mention your series of papers on British Fossil Crinoids, your important memoir on the Crinoidea of Gotland, and your latest published work on the Triassic Echinoderms of Bakony. Nor must I omit to add your important contribution on Echinoderma to Sir Ray Lankester's Treatise on Zoology.

In your task you have been so successful that the Council has decided to ask you to accept this year a Lyell Medal, which was intended by its founder to be awarded "for the encouragement of Geology or of any of the allied sciences by which they shall consider Geology to have been most materially advanced".

Dr. Bather, in reply, said:—

Mr. President,—I had thought of much to say on this occasion, but the generous and flattering terms in which you have recounted the things that I have done have made me think rather of those things that I have left undone. If the little that I have done has seemed of such service to Geology as to merit this high distinction, while I am proud to receive it, I cannot forget the friends in all parts of the world who have so greatly facilitated my work by the loan of valuable specimens. And the thought of them again reminds me of the material accumulated, but still untouched. A palæontologist at the British Museum is often envied, much as Dionysius of Syracuse was envied by Damocles. If any Damocles were to take my place he would see, it is true, a rich feast of Cystids and Crinoids laid before him. But the chains of office would perpetually hinder him from feeding, and every day he would dread the fall of a sword in the shape of a peremptory letter demanding the immediate return of some necessary specimen.

It is my hope, sir, that this award by so high a tribunal may convince my friends and superiors that I really have made good use of the rich material entrusted to me; certainly it will encourage me to make my own future labours no less deserving of their continued patience. For these reasons and for many others, which must remain unexpressed, I offer to the Council my heartfelt thanks.

The President then presented the other Lyell Medal to Dr. Arthur Walton Rowe, F.G.S., addressing him as follows:—

Dr. Rowe,—It is no small pleasure to me that it is my duty, as President of the Geological Society, to ask your acceptance of the Lyell Medal which the Council of the Society has awarded to you, in recognition of the great service which you have rendered to British Geology by your researches on the succession and distribution of the zones of the English Chalk. Using delicate and refined means of your own for the development of the fossils, and collecting the latter from the successive horizons with the most scrupulous care, you soon convinced yourself that the key to the evolution of the Echinoids and the basis for their classification was to be found in their succession in time. The first important outcome of your work was the classic paper on the evolution of the genus *Micraster* published by this Society in 1899. The lines of advance in these organisms having thus been made out, you proceeded to use the characteristic forms as time-indices, with the result that you were able, not only to make a satisfactory subdivision of the White Chalk in Kent, but to extend the zonal lines thus marked out throughout the country. In this manner you carried on the work so ably begun by Professor Charles Barrois, and erected a worthy superstructure upon the solid foundations laid by him. The influence which your research has exerted upon other investigators in stimulating them to work, either in direct association with yourself or independently, but always assisted and encouraged by your active help and sympathy, is a sufficient testimony to its value.

Dr. Rowe replied in the following words:—

Mr. President,—That every man is glad to have his work recognized is, I suppose, a truism; but, while I deeply appreciate the all too kind remarks which you have just made, I cannot but feel that the recognition is on far too generous a scale. Very warmly I welcome the reference which you have made to my amateur colleagues in the field. We have but one common aim, and that is to trace the centres of distribution of species in the Chalk, together with their vertical and horizontal range, and especially to work out the fascinating problems in evolution in which that formation is so rich. And, if a certain little biological indiscretion, which I had the temerity to offer to the Council in the year 1899, has borne fruit in this last direction, I shall not regret the anxious complications which attended its somewhat protracted parturition.

But while I claim all praise for the amateur worker, let us not forget the labours of one whose philosophical and masterly grasp of the whole Cretaceous

System has laid us all under a lasting obligation. I refer, of course, to Mr. A. J. Jukes-Browne.

All of us, however, professional and amateur worker alike, owe our allegiance to, and draw our inspiration from, that great Frenchman, Charles Barrois. But for him we should still be floundering in the pre-zonal chaos of a "Chalk with flints" and a "Chalk without flints". As I have said, when speaking in another place, I ask no better verdict from posterity than to be regarded as a faithful exponent of Barrois. Higher praise no worker in the Chalk can ask than this, nor can he attain to higher office.

And, sir, in tendering to you and to the Council my grateful thanks for this high honour, it only remains for me to say that I accept it, not for my own merits, but as a recognition of the splendid achievements of my fellow-workers in this most fruitful field of investigation.

The President, in presenting to Professor Othenio Abel, Ph.D., the Bigsby Medal, addressed him as follows:—

Professor Abel,—The Bigsby Medal has in former years been awarded to workers in many branches of Geology: to stratigraphers, petrologists, palæontologists, and to those whose special subject has been tectonics or physiography. It has been given to the geologists of many lands. It is, however, more than thirty years since it was given to one whose chief work lay in the domain of Vertebrate Palæontology, and it has never yet been awarded to a native of your country.

In awarding it on this occasion, the Council wish to mark their appreciation of your investigations upon the higher Vertebrata, more especially on the Cetacea and Sirenia. Your great memoirs on the Upper Miocene Toothed Whales of Belgium and on the Sirenians of the Mediterranean Territory of Austria are admirable examples of descriptive work, completed by philosophical deductions; while your numerous smaller papers, both on mammals and on lower vertebrates, are full of suggestive speculations based on a detailed study of all the available materials.

The vigour and thoroughness of the work which you have accomplished makes it clear that, in the words of the Founder, "you are not too old for further work," while the number and excellence of your publications prove that "you are not too young to have done much".

Count Alexander Hoyos, Secretary to the Imperial and Royal Austro-Hungarian Embassy, expressed, on behalf of the Ambassador, his Excellency's regret at his unavoidable absence on that occasion, as well as his gratification that so signal an honour had been conferred by the premier Geological Society of the world upon his distinguished fellow-countryman, Professor Abel, and thus for the first time upon a native of Austria.

Professor Abel, having requested permission to use the German language in expressing his thanks, replied as follows:—

Herr Präsident,—Ich bitte, für die Verleihung der Bigsby Gold Medal meinen wärmsten und tiefgefühlten Dank entgegennehmen zu wollen.

Die Zuwendung der Bigsby Medal bedeutet für mich eine ausserordentliche und unerwartete Ehrung, und ich empfinde dieselbe in ihrer ganzen Bedeutung. Ich schätze diese Auszeichnung um so höher, als sie mir gerade von Seiten der Geological Society of London verliehen wurde, der ältesten und unbestritten angesehensten geologischen Gesellschaft der Welt; ihre Mitgliederliste umfasst seit ihrer Gründung bis auf den heutigen Tag Namen, deren Träger auf dem Gebiete der Geologie und Palaeontologie unsere Führer und Meister gewesen sind.

Ich bin stolz darauf als der erste Oesterreicher dieselbe Medaille erhalten zu haben, welche 1877 an Othniel Charles Marsh und 1879 an Edward Drinker Cope verliehen wurde. Aber diese Erinnerung weckt in mir die Besorgnis, ob ich imstande sein werde, mich wie Marsh und Cope in Zukunft der mir verliehenen Auszeichnung nicht unwürdig zu erweisen.

Seit einer Reihe von Jahren mit Untersuchungen über fossile Vertebraten beschäftigt, war es stets mein Bestreben, ihre genetischen Zusammenhänge und Entwicklungswege sowie die Geschichte ihrer Anpassungen zu verfolgen. Auf dem Wege weiterschreitend, den mir mein hochverehrter Freund Louis Dollo gewiesen hat, will ich auch ferner meine ganze Kraft diesen Untersuchungen zuwenden, um mich der mir heute zuteil gewordenen Ehrung nicht unwürdig zu erweisen; die Bigsby Medal wird ein neuer Ansporn für mich sein, in meinen wissenschaftlichen Arbeiten nicht zu erlahmen.

The President then presented the Balance of the Proceeds of the Wollaston Donation Fund to Professor Owen Thomas Jones, M.A., addressing him as follows:—

Professor Jones,—Up to within the last few years the wide-spreading and rugged expanse of Central Wales was tinted upon our geological maps of a uniform pink colour, almost as if it were composed of the strata of a single sub-formation. But, little by little, geologists of the younger generation have been working out the details of its complicated structure, collecting the fossils, and bringing its component rock-groups into line and harmony with their zone-fellows elsewhere. In this work of reformation you have taken a full share. While still a member of the Geological Survey you devoted your holidays to the enthusiastic study of these complicated strata of your native land, and in your Plynlimmon paper you have most successfully unravelled the sequence and structure of that 'heart of Mid-Wales' and of much of the ground to the west. I have much pleasure in handing to you the Balance of the Proceeds of the Wollaston Fund, which the Council has awarded to you in recognition of the good work that you have done, and as an incentive to you to complete it—a task which will be rendered easier by your appointment as Professor of Geology in the University College of Wales at Aberystwyth.

In presenting the Balance of the Proceeds of the Murchison Geological Fund to Mr. Edgar Sterling Cobbold, F.G.S., the President addressed him in the following words:—

Mr. Cobbold,—Although the county of Shropshire was to Murchison a veritable Golconda, he was not able to remove all its treasure or to wrest all its secrets, but left a generous reward for his many successors. Among them, by your excavations in a district rendered difficult by earth-movement and thick soil-covering, you have succeeded in obtaining a new Cambrian sub-fauna and an array of new genera and species of Trilobites. You have not only made important contributions to what was hitherto known of the local succession of the subdivisions of those ancient rocks, but you have by your figures and descriptions added much to our previous knowledge of their fossils. It is appropriate that the Murchison Fund should pass into 'Siluria' and to one working on Older Palæozoic rocks, as a token of the good-will of your fellow-workers, a mark of their pleasure in your achievement, and an expression of their confidence in your future work.

The President then presented to Dr. Charles Gilbert Cullis, F.G.S., the Balance of the Proceeds of the Lyell Geological Fund, addressing him as follows:—

Dr. Cullis,—I need hardly express the pleasure that it gives me to hand the Balance of the Lyell Fund to a colleague for whom I have so much respect, and in whose judgment and ability I place so much confidence. You are able to look back upon a great number of students who have passed out into the world bearing the marks of your training, and you have reason to be proud of the work that they are doing. Your original contribution to the study of the gore of the Funafuti Boring, with its careful record and explanation of the occurrence of calcite, aragonite, and dolomite therein; your work on the Forest of Dean and May Hill; and your discovery of the occurrence of dolomite crystals in the Keuper Marls, have all been the fruit of painstaking research, with the gratifying result of forwarding the researches of others. All those

who have heard you lecture on your own work or on other geological subjects, have been greatly impressed by your careful choice of matter, the charm of your style, and the lucidity of your expression. Certainly this award is given to one by whom "Geology has been materially advanced".

In presenting an Award from the Proceeds of the Barlow-Jameson Fund to Mr. John Frederick Norman Green, M.A., the President addressed him in the following words:—

Mr. Green,—It is not often that it is given to a geologist to succeed in producing conviction by a single paper, still less by his first contribution to the science; but such has been your good fortune in the paper published by this Society on the rocks of St. Davids. The appropriateness of your methods, your careful recognition of lithological horizons, the accuracy and detailed minuteness of your mapping, even the careful selection of the most conclusive spot for excavation, have engendered such confidence in the result, that we may regard as solved one of the chief difficulties in a most difficult region. The Council has made to you an award from the Barlow-Jameson Fund "for the advancement of Geological Science", in the assurance that you will carry the same accuracy and delicacy of work into other fields.

The President then proceeded to read his Anniversary Address, giving first of all Obituary Notices of several Fellows deceased since the last Annual Meeting, including Prebendary W. H. Egerton (elected a Fellow in 1832); T. R. Polwhele (el. 1858); Major-General W. E. Warrand (el. 1859); Captain G. E. Shelley (el. 1862); the Rev. R. B. Watson (el. 1864); Dr. Theodore Cooke (el. 1866); Mr. C. Fox-Strangways (el. 1873); Mr. A. H. Stokes (el. 1874); the Rev. G. F. Whidborne (el. 1876); Mr. T. M. Heaphy (el. 1876); and Mr. C. Bird (el. 1882).

He then made reference to the chief event of the year in the Society's affairs—the resolution not to continue to maintain the Museum, but to offer its contents to a National Museum or Museums. He pointed out that the unanimous acceptance, at the annual meeting, of the Report of the Council was confirmatory of the action of the special general meeting which had originally passed the resolutions.

The subject of the Address was the consideration of Geology as Geographical Evolution. The main factors of the geographical evolution of an area were considered to be the alternation of upward and downward movement. Each geographical cycle, passing from the period of maximum depression through uplift into terrestrial conditions and then back again towards depression and submergence, would be expressed in the geological record by a corresponding set of deposits consisting of 'thalassic', 'shoreward', 'terrestrial', 'estuarine', and again 'thalassic' deposits following each other in this order. Each of these phases was considered in some detail, and attention was drawn to difficulties in interpretation and correlation, and to the principles according to which the depositional phenomena should be translated into terms of geography.

Despite the fact that several cycles of geography and deposition had swept over Britain, there had been comparatively little repetition of phase in the deposits, and two or three examples were taken to illustrate cases of correspondence and non-correspondence of deposits formed during similar stages in the succeeding cycles. The careful

and minute study of existing geographical conditions was strongly advocated, as the key to the interpretation of the geological record; and it was urged that the utmost possible use should be made of palæogeographical maps, both as a means of expressing ascertained fact and as affording a focus for new critical investigation.

The association of the phases of earth-movement with igneous activity was next briefly treated, as also the connexion of movement with rock-structure and existing physiography.

Finally, geographical evolution was examined as the spur to organic evolution, and it was urged upon palæontologists that they should endeavour to ascertain to what extent periods of slow or rapid evolution corresponded with epochs of physical change.

The Ballot for the Council and Officers was taken, and the following were declared duly elected for the ensuing year:—COUNCIL: Henry A. Allen; Tempest Anderson, M.D., D.Sc.; Charles William Andrews, B.A., D.Sc., F.R.S.; Henry Howe Arnold-Bemrose, J.P., Sc.D.; George Barrow; Professor Thomas George Bonney, Sc.D., LL.D., F.R.S.; Professor William S. Boulton, B.Sc.; James Vincent Elsden, D.Sc.; John Smith Flett, M.A., D.Sc.; Professor Edmund J. Garwood, M.A.; Sir Archibald Geikie, K.C.B., D.C.L., LL.D., Sc.D., Pres.R.S.; Alfred Harker, M.A., F.R.S.; Robert Stansfield Herries, M.A.; Bedford McNeill, Assoc.R.S.M.; John Edward Marr, Sc.D., F.R.S.; George Thurland Prior, M.A., D.Sc.; Professor Sidney Hugh Reynolds, M.A.; Professor William Johnson Sollas, LL.D., Sc.D., F.R.S.; Aubrey Strahan, Sc.D., F.R.S.; Herbert Henry Thomas, M.A., B.Sc.; Professor W. W. Watts, Sc.D., M.Sc., F.R.S.; the Rev. Henry Hoyte Winwood, M.A.; and Arthur Smith Woodward, LL.D., F.R.S., F.L.S.

OFFICERS:—*President:* Professor W. W. Watts, Sc.D., M.Sc., F.R.S. *Vice-Presidents:* Charles William Andrews, B.A., D.Sc., F.R.S.; Alfred Harker, M.A., F.R.S.; John Edward Marr, Sc.D., F.R.S.; Professor W. J. Sollas, LL.D., Sc.D., F.R.S. *Secretaries:* Professor Edmund J. Garwood, M.A.; Arthur Smith Woodward, LL.D., F.R.S., F.L.S. *Foreign Secretary:* Sir Archibald Geikie, K.C.B., D.C.L., LL.D., Sc.D., Pres.R.S. *Treasurer:* Aubrey Strahan, Sc.D., F.R.S.

2. *February* 22, 1911.—Professor W. W. Watts, Sc.D., M.Sc., F.R.S., President, in the Chair.

The following communication was read:—

"The Geology of the Districts of Worcester, Robertson, and Ashton (Cape Colony)." By R. H. Rastall, M.A., F.G.S.

After a brief description of the physiography of the district and the general sequence of the rocks composing it, in which the incompleteness of the stratigraphical record is especially noted, a detailed account is given of the structure and characters of the Malmesbury rocks of Worcester and the region near that town. These are shown to include a lower and an upper sedimentary series, predominantly gritty and slaty respectively, and evidently of great thickness, probably over 20,000 feet. The upper division is pierced by granitic dykes, which have been subsequently crushed and foliated, forming 'phyllite gneiss'. Certain bands of limestone are metamorphosed by them to pure-white marble. A remarkable isolated mass of igneous rock in Brewels Kloof appears to be intrusive, but the rock is andesitic in character. A thin though conspicuous band of ottrelite-schist has been found in Waai Kloof and in the Hex River Pass. All these rock-types are described in detail. Similar but somewhat less

detailed treatment is accorded to the Malmesbury rocks of Robertson and Ashton, and a petrographical description is given of the large granite intrusion of Wolve Kloof, Robertson.

The distribution and characters of the rocks of the Cape and Karroo Systems are only dealt with in so far as they throw light on the principal subject of the paper; but a fairly full description is given of the occurrences of Enon Conglomerate, which is shown to occupy a series of isolated basins, arranged along an east-and-west line, and to lie with a strong discordance upon all the older rocks. After a careful examination of the ground, it is concluded that the Enon Conglomerate does not overlap the Worcester–Swellendam Fault, as indicated in the official maps; and that conglomerate does not appear to contain any fragments of the Malmesbury rocks, which cannot therefore have been exposed when it was formed.

After a careful discussion of all the available evidence it is concluded that the Worcester-Swellendam Fault, which has a maximum throw of probably 10,000 feet, is in great part of post-Cretaceous age, although there are indications of earlier movement along the same line of fracture. From a study of the dominant trend-lines of South-Western Cape Colony it is concluded that the district in question is situated at or near the central line of the syntaxis of two great sets of folds at right angles, which have assumed a fan-shaped arrangement in plan, and that the great fault is a line of fracture and subsidence running transversely across these lines of folding. The folding and the faulting are clearly phases of one general series of events, and the faulting probably resulted from a diminution or even reversal of the pressure which had previously given rise to the folding.

Baron Ferencz Nopcsa, jun., then gave some account of the Geology of Northern Albania. He said that he had examined the greater part of the Province of Scutari in Western Turkey, and recognized three distinct structural units: namely, the North Albanian platform, the folded Cukali, and the eruptive region of Merdita. In the first region Mesozoic limestone of all periods predominates; in the second region Mesozoic radiolarian chert is found; while in the third region Mesozoic clastic rocks, volcanic tuffs, and eruptive masses are abundant. The first and third units are not folded, but are, at least in part, overthrusts from the north and south respectively above the second (intermediate) unit, which is strongly folded. In Northern Albania Upper Carboniferous and Permian rocks are also distinguishable, and there is an Eocene Flysch.

CORRESPONDENCE.

THE HIGH-LEVEL GLACIAL DRIFT AND THE LAND-ICE HYPOTHESIS.

Sir,—In your January number Mr. T. Crook raises an important question concerning the probable method of transport of the boulders and shells which are now found at levels much higher than their probable points of origin. Although he quotes two passages from the writings of Sir Archibald Geikie and Professor Bonney pointing out that it is difficult to understand how the ice could ascend steep slopes

to heights of more than a thousand feet, he suggests what seems far more difficult to grasp, i.e. that the lower layers of ice, owing to the formation of internal shear-planes, rose locally to the surface and carried with them portions of the ground moraine.

Being an advocate of the view that an ice-sheet may drag along with it portions of the floor over which it moves, especially if the floor be frozen, and carry such portions up slopes of more than a thousand feet, I do not resent the rendering Mr. Crook gives of such views; neither do I dispute the fact that, as he suggests, upward thrusts and contortions may be seen in glaciers. My experience, however, is that such signs of 'upward thrust', by which I understand him to mean shear, are confined to portions of the glacier where the surface is rapidly melting. In such places the ice is in compression and the glacier surface is rising to make up for the loss.

Thrust is credited with far too much importance as a cause of glacier flow. Rather should we attribute the flow to the absence of support in front. A glacier moves much as does a river. Where the slope is small the velocity of the ice or water is slow and the river or glacier deep; where the river or glacier is wide the flow is slow and

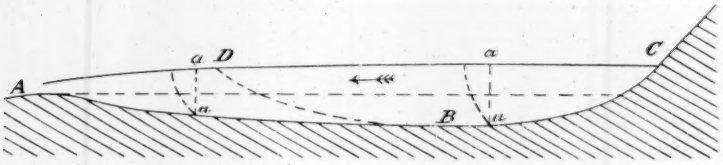


FIG. 1.

the ice or water shallow. Gravity is acting upon every portion of the mass, and the speed and thickness everywhere adjust themselves so as to pass the volume of ice or water to be got rid of. It has been suggested that the forces due to gravity acting on a glacier could not cause shear in its mass; for a similar mass of soft clay would not shear, and clay is much less capable of resisting shear than is ice. Clay, however, is not a viscous substance, and on a slope the material in front acts as a permanent buttress to prevent motion. With ice the front gives way, either by suffering longitudinal compression or by flow, and the rear portions follow.

When large glaciers are concerned the flow is quite regular; there may be shear where the stresses are sufficiently great, but such shear-planes are strictly related to the floor upon or against which the ice rests. Any local upthrust would soon raise a mound on the glacier surface, the weight of which would check further uprise. Many seem to experience difficulty in understanding how a glacier can move up a slope and drag rock masses along with it. Now the movement of a glacier is not necessarily due to the slope upon which it rests. The motion is due to the slope of the upper surface of the ice, which may be in the opposite direction to that of the floor upon which it rests.

We will suppose that the glacier rests in a hollow as in Fig. 1.

Here the upper surface of the ice slopes from *C* towards *A*, and the flow is in the same direction. All the ice in the hollow is in equilibrium and is urged in the direction of the arrow by that portion which is above the lip *A* and extends towards *C*. Very little force indeed is therefore required to raise the ice from *B* to *A*. The ice will get thinner as it advances, and the slope of the upper surface at each point will assume the angle required to deliver the proper volume of ice at any cross section, *aa*, *aa*.

If the glacier floor were immovable and the ice were frozen to it the rate of motion at the bottom would be very small indeed if local shear did not take place. We have proof, however, that the glacier not only undergoes internal distortion, but that it frequently slips over the floor as well. In Spitzbergen, where the ground is frozen for hundreds of feet in depth, it is clear that ice flowing over such a floor would freeze to it and drag it along. Under these circumstances large masses of frozen gravel and sand would become incorporated in the lower portion of the glacier together with boulders, and these inclusions would be thawed out and redistributed when they came to their journey's end. The 'pushing' effect of the ice front against loose material as the glacier advances is no doubt considerable; but it is rather to the work effected by the debris-charged lower portion that the transport of material is due.

Mr. Crook suggests that the transport and lifting are more likely to be the result of upward shear in the ice, say along the dotted line *BD* in the figure, than along the floor from *B* to *A*. This seems very unlikely.

If the Rhone Valley were filled with ice up to about the level of the numerous hanging valleys the smaller glaciers from these valleys would flow on to and over the surface of the main Rhone Glacier, and subglacial moraine would thus find its way to the upper levels. I do not think it at all likely, however, that bottom moraine would find its way to the surface by upthrusts in the ice.

R. M. Deeley.

Inglewood, Longcroft Avenue,
Harpenden, Herts.
March 13, 1911.

GEOLOGY OF PADSTOW AND CAMELFORD.

Sir,—In the notice of the Geological Survey Memoir on the Geology of Padstow and Camelford (p. 136) it was stated that the two new maps which accompany that memoir "show, for the first time, the divisions of Lower, Middle, and Upper Devonian". So far as the one-inch maps of the Geological Survey are concerned, this is quite correct. Nevertheless, mention should have been made of the fact that the main divisions of the Devonian rocks had been represented on a small map by Mr. W. A. E. Ussher (Trans. Roy. Cornwall Geol. Soc., 1891, p. 273). That map was constructed from lithological descriptions in De la Beche's Report, the data being interpreted by Mr. Ussher from his intimate knowledge of the Devonian rocks in South Devon. Although the relative position of the Meadfoot and Looe Beds and of the Dartmouth Slates was not then understood, the